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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. D01-4120/TK
 First Inventor or Application Identifier Kazuhiko Nakamura
 Title HIGHLY STABLE RESIN, HARDENABLE RESIN
 Express Mail Label No. EL366426110US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
 (Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages 118]
 (preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 2]
4. Oath or Declaration [Total Pages 3]
 a. ☒ Newly executed (original or copy)
 b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
 (for continuation/divisional with Box 16 completed)
 i. ☐ DELETION OF INVENTOR(S)
 Signed statement attached deleting
 inventor(s) named in the prior application,
 see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

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5. ☐ Microfiche Computer Program (Appendix)
 6. Nucleotide and/or Amino Acid Sequence Submission
 (if applicable, all necessary)
 a. ☐ Computer Readable Copy
 b. ☐ Paper Copy (identical to computer copy)
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ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
 8. ☐ 37 C.F.R. § 3.73(b) Statement of Power of Attorney
 (when there is an assignee)
 9. ☐ English Translation Document (if applicable)
 10. ☐ Information Disclosure Statement (IDS)/PTO-1449 [Copies of IDS Citations]
 11. ☐ Preliminary Amendment
 12. ☒ Return Receipt Postcard (MPEP 503)
 (Should be specifically itemized)
 13. ☐ * Small Entity Statement filed in prior application,
 Statement(s) Status still proper and desired
 (PTO/SB/09-12)
 14. ☒ Certified Copy of Priority Document(s) Japanese
 (if foreign priority is claimed) 11-227072&
 15. ☒ Other: 11-288803

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HIGHLY STABLE RESIN, HARDENABLE RESIN COMPOSITION,
PRODUCTION METHOD THEREFOR, COLOR FILTER
AND LIQUID CRYSTAL PANEL

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a highly stable resin without the risk of bringing about undesired increase of the molecular weight or the viscosity in storage, use, or handling, such as a photo-curing resin with a good storage property, and a production method therefor.

Moreover, the present invention also relates to a hardenable resin composition containing a highly stable hardenable resin, capable of easily adjusting or evening the film thickness of a coated film without the risk of viscosity increase in storage or coating, and a production method therefor.

Furthermore, the present invention relates to a resin with excellent stability and transparency, a hardenable resin composition containing such a resin, and a production method therefor.

Still further, the present invention relates to a color filter and a liquid crystal panel with little color irregularity and contrast irregularity, with a protection film of a coloring layer and a spacer of a liquid crystal layer formed, using a highly stable hardenable resin composition, in particular, a

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Recently, as a flat display for a personal computer, color liquid crystal display devices have been propagated rapidly. As shown in FIG. 1, a color liquid crystal display device 101, in general, has a structure wherein a color filter 1 and an electrode substrate 2 such as a TFT substrate are faced with each other so as to provide a gap part 3 of about 1 to 10 μm , with a liquid crystal compound L filled in the gap part 3 and the periphery thereof sealed by a sealing member 4. The color filter 1 comprises a structure including a black matrix layer 6 formed in a predetermined pattern for blocking the light in the boundary part between the pixels, a coloring layer 7 with a plurality of colors (in general, three primary colors including red (R), green (G), and blue (B)) arranged in a predetermined order for forming each pixel or recently, a color filter, a protection film 8, and a transparent electrode film 9 successively laminated on a transparent substrate 5 in this order from the side close to the transparent substrate. Moreover, an alignment layer 10 is provided on the inner surface side of the color filter 1 and the electrode substrate 2 facing thereto. Furthermore, pearls 11 having a constant particle size are dispersed as a spacer in the gap part 3 for constantly and homogeneously maintaining the cell gap between the color filter 1 and the electrode substrate 2. A color image can be obtained by controlling the light transmittance of the pixels

colored in each color or the liquid crystal layer behind the color filter.

The protection film 8 formed in the color filter serves for protecting the coloring layer and for flattening the color filter in the case a coloring layer is provided in the color filter. In a color liquid crystal display device, in the case the flatness of the transparent electrode film 9 is deteriorated due to existence of gap irregularity derived from the waviness on the surface of the transparent substrate of the color filter, gap irregularity among the R, G and B pixels, or gap irregularity within each pixel, color irregularity or contrast irregularity is generated so as to give rise to a problem of the image quality deterioration. Therefore, a high flatness is required to the protection film.

In the case the fine particle-like pearls 11 as shown in FIG. 1 are dispersed as the spacer, the pearls are dispersed randomly, independent from being behind the black matrix layer 6 or behind the pixels. In the case the pearls are disposed in the display area, that is, in the pixel part, a back lighting beam transmits the pearl part, and further, the orientation of the liquid crystal is disturbed in the vicinity of the pearls so that the display image grade is deteriorated remarkably. Then, as shown in FIG. 2, instead of dispersing the pearls, column-like spacers 12 having a height corresponding to the cell gap are formed on the inner surface side of the color filter in the area coinciding with the black matrix layer 6.

The above-mentioned protection film 8 and the

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column-like spacers 12 can be formed with a resin. In consideration of the adhesion property and the sealing property of the sealing part, the protection film 8 is preferably one capable of covering only the area of the transparent substrate with the coloring layer formed thereon. Moreover, the column-like spacers 12 need to be formed accurately in the area with the black matrix layer formed, that is, in the non-display area. Therefore, the protection film and the column-like spacers came to be formed with a photo-curing resin capable of easily limiting the area to be hardened by a photo mask.

Furthermore, in the case the surface applied with a photo-curing resin is developed with an organic solvent after exposure for forming the protection film or the column-like spacers, since handling and the waste liquid process are troublesome so that it is not satisfactory in terms of economy and stability, a photo-curing resin allowing an alkaline development after exposure has been developed by introducing an acidic group in a photo-curing resin.

As an alkaline-soluble photo-curing resin, for example, o-cresol novolak epoxy acrylate, or the like, having about 2,000 weight average molecular weight is known. The resin has a carboxylic acid group defining the alkaline solubility. However, since the resin uses a monomer component as an acryloyl group defining the curing property, the reliability in film formation is low. For example, it involves the risk of the

residual monomer unit elution to the liquid crystal part. Furthermore, the film thickness may be reduced due to a large amount of the elution in the alkaline development.

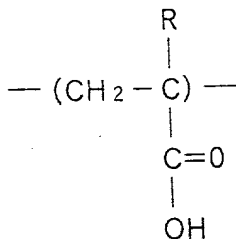
Moreover, as a method for introducing a radical polymerizable group such as an acryloyl group into the molecular structure of a compound for providing the photo curing property, for example, a method of introducing a radical polymerizable group such as a methacryloyl group to an end by reacting of diols with excessive diisocyanate for preparing a reaction product with an isocyanate group remaining on the end, and reacting the isocyanate group of the reaction product with 2-hydroxyl ethylmethacrylate for producing urethane acrylate, is known. However, according to the method, as a principle, a (meth)acryloyl group can be introduced to only both ends of the molecular structure. Furthermore, although a method of radical polymerization by partially containing a compound having two or more radical polymerizable groups in a molecular such as a (meth)acryloyl group can be conceivable, the content of the radical polymerizable group cannot be controlled as well as a problem of gelation is also involved.

As mentioned above, although it is convenient to form the protection film and the column-like spacers of a color film with a photo-curing resin, it is difficult to control the amount of the alkaline soluble group such as a carboxyl group and the radical polymerizable group such as a (meth)acryloyl group

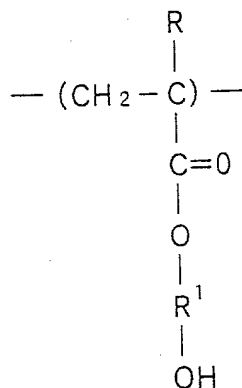
according to the conventional photo-curing resin in consideration of the curing property and the alkaline solubility thereof.

According to the undisclosed knowledge obtained by the study of the present inventor, since the amount of the alkaline soluble carboxyl group and the radical polymerizable (meth)acryloyl group can be adjusted freely according to a copolymer resin having a principal chain comprising at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2), with at least a part of the carboxyl group or the hydroxyl group thereof bonded with a (meth)acryloyloxy alkyl isocyanate compound represented by the below-mentioned formula (5) according to reaction of the isocyanate group of the compound, it is extremely suited as a photo-curing resin:

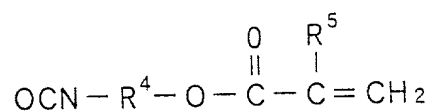
Formula (1)



Formula (2)



Formula (5),



wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, R¹ is an alkylene group having 2 to 4 carbon atoms, R⁴ is an alkylene group, and R⁵ is hydrogen or methyl.

However, it is learned that in the case the above-mentioned copolymer resin is dissolved or dispersed in a solvent and left, the molecular amount is increased rapidly so as to raise the viscosity. According to our experiment, it is confirmed that the thickening phenomenon proceeds even in a room temperature, and proceeds more rapidly as the storage temperature is higher. Moreover, in an experiment utilizing the GPC (gel permeation chromatography), only by dissolving the above-mentioned copolymer resin in a solvent and leaving the

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same in a room temperature for two weeks, the molecular weight, which was 69,000 at the time of preparation, was increased to as much as 98,000, and the viscosity of the solution became 1.17 times. Furthermore, by storing the copolymer resin at 70 °C for three days, the molecular weight, which was 69,000 at the time of preparation, was increased to as much as 340,000, and the viscosity of the solution became 2.14 times. Moreover, it is also confirmed that the thickening phenomenon becomes further remarkable by mixing the copolymer resin with a thermosetting epoxy resin, an acrylic monomer, a polymerization initiator, or the like, dissolving in a solvent, and storing in the state of a coating liquid to be actually used.

Since the above-mentioned copolymer resin gives rise to such a thickening phenomenon, it is extremely troublesome in terms of storage, film thickness adjustment at the time of coating, maintenance of the homogeneity of the film thickness, or the like. That is, after once preparing a photo-curing resin composition coating liquid by dissolving the above-mentioned copolymer in a solvent and mixing with other materials, refrigeration storage is prerequisite and a long term storage is not possible. Moreover, even in the case thickening in storage can be avoided, since the coating operation is executed, in general, in a room temperature, the viscosity of the coating liquid rises rapidly during the operation of a day. Therefore, unless the viscosity of the coating liquid is checked frequently

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so as to modify the coating condition not only before starting the operation but also during the operation, the coated film thickness cannot be adjusted constantly. Furthermore, in the case the viscosity of the coating liquid rises too much, even if the coated film thickness can roughly be adjusted by modification of the coating condition, the coating irregularity cannot be avoided so that the film thickness homogeneity of the coated film cannot be maintained. Moreover, it is also difficult to reuse the remained portion of a coating liquid once used in a room temperature the other day, or to use the remained coating liquid with a new coating liquid added thereto.

In particular, the extremely high accuracy and homogeneity are required for the film thickness of the protection film for covering the coloring layer of the color film or the height of the column-like spacers for ensuring the cell gap. Compared with the protection film to be formed continuously in a collective area on the coloring layer, since the column-like spacers are formed intermittently according to the black matrix layer formation area by a height more than double as much as the height of the coloring layer, the size fluctuation can easily be brought about due to increase of the viscosity of the coating liquid. Moreover, in the case the coating resin came to have too high a molecular amount, the shape of the column-like spacers is deteriorated so that the strength as a spacer and other dynamic characteristics are deteriorated

as well.

Therefore, in the case of forming a protection film or a column-like spacer of a color filter, in particular, of forming the column-like spacer, using a coating liquid of a photo-curing resin composition containing the above-mentioned copolymer resin, the thickening phenomenon of the coating liquid should be prohibited to a minimum level.

Furthermore, a good transparency is required to a resin for forming a coloring layer or a protection layer of a color film. However, according to the knowledge of the present inventors, the above-mentioned copolymer resin does not have a sufficient transparency.

SUMMARY OF THE INVENTION

In view of the circumstances, the present invention has been achieved, and a first object thereof is to provide a method for improving the storage property and the stability of the above-mentioned photo-curing copolymer resin, and an improved hardenable polymer not liable to cause the viscosity increase compared with the above-mentioned photo-curing copolymer resin.

A second object of the present invention is to provide a method for improving the storage property and the stability of resins as a whole, conceived to cause the viscosity increase

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according to the same principle as the above-mentioned photo-curing copolymer resin due to the molecular structure, and an improved resin not liable to cause the viscosity increase.

A third object of the present invention is to provide an improved photo-curing resin composition containing the above-mentioned improved hardenable polymer, capable of easily controlling the coating operation, and not liable to generate the coating irregularity, and a production method for the photo-curing resin composition.

A fourth object of the present invention is to provide a resin and a photo-curing resin composition having the excellent stability, not liable to cause the viscosity increase, and having the excellent transparency, and a production method therefor.

A fifth object of the present invention is to provide a color filter and a liquid crystal panel with a protection film of a coloring layer and/or a column-like spacer of a cell gap formed, using the above-mentioned improved photo-curing resin composition.

According to the present invention, a highly stable resin comprising a polymer obtained by reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, and further

reacting the same with an alcohol can be provided.

By reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, a residual group of the isocyanate compound can be introduced to the part of the acidic functional group or the hydroxyl group of the material polymer, but a part of the acidic functional group is assumed to be an acid anhydride group according to the dehydration effect of the isocyanate compound. Then, by dissolving or dispersing the polymer obtained by the above-mentioned reaction in a solvent and leaving, an acid anhydride group of a polymer molecule is assumed to react with a hydroxyl group of another polymer so as to ester-bond and cross-link the molecules, resulting in the molecular weight increase and the viscosity rise. In contrast, by further reacting the polymer obtained by the above-mentioned reaction with an alcohol, the alcohol is assumed to be added to the acid anhydride group part so as to be esterified for inhibiting the cross-linking reaction among the polymer molecules, and as a result, the molecular weight increase and the viscosity rise can be prevented.

Such a highly stable resin obtained by the alcohol treatment is assumed to have a molecular structure having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl

group, wherein an isocyanate compound is amido-bonded with at least a part of the acidic functional group via an isocyanate group of the isocyanate compound and/or urethane-bonded with at least a part of the hydroxyl group, and an alcohol is ester-bonded with at least a part of the acidic functional group via a hydroxyl group of the alcohol.

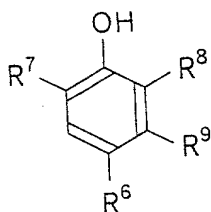
In order to produce the above-mentioned highly stable resin, for example, an alcohol can be added to a reaction liquid obtained by reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, or a solution prepared by dissolving or dispersing the polymer produced from the reaction liquid again in a solvent, before viscosity rise of the reaction liquid or the solution, or before completion of viscosity rise. In order to stop the viscosity rise of the polymer solution substantially completely, it is preferable to leave or heat the polymer solution for a predetermined time after adding the alcohol for maturation of the alcohol treatment polymer.

In the present invention, it is preferable that polymerization reaction of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group is executed, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator at the

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time of forming the material polymer for the highly stable resin, that is, the principal chain part of the highly stable resin. Moreover, it is preferable that at the time of reacting the material polymer with the isocyanate compound, a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16) is used. In the case a highly stable resin is synthesized, using the above-mentioned specific polymerization initiator and/or polymerization inhibitor, the obtained reaction liquid shows a high light transmittance in the visible area and the ultraviolet area. Therefore, by using the reaction liquid containing the highly stable resin as the coating liquid as it is, a film with the excellent transparency can be formed. Moreover, in the case the highly stable resin is a photo-curing copolymer resin, the exposure sensitivity can be improved by improving the light transmittance in the ultraviolet area.

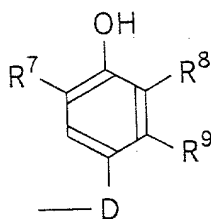
Formula (10)



wherein R⁶ is hydrogen, an alkyl group having 1 to 5

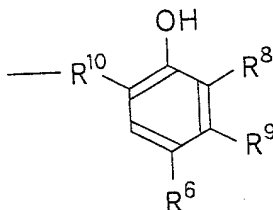
carbon atoms, or the below-mentioned formula (11):

Formula (11)



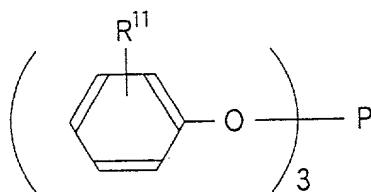
wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁷ is hydrogen or an alkyl group having 1 to 10 carbon atoms. R⁸ is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

Formula (12)



wherein R¹⁰ in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁹ is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R⁷ and R⁸ is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R^{11} is hydrogen or an alkyl group having 1 to 20 carbon atoms.

By using the above-mentioned specific polymerization initiator and/or polymerization inhibitor, for example, a 3-methoxy butyl acetate solution of a 20% by weight resin solid component prepared by diluting the reaction liquid containing the highly stable resin in a 3-methoxy butyl acetate as it is or dissolving the highly stable resin separated from the reaction liquid placed in a 1 cm square quartz cell shows a 60% or more light transmittance of a visible area at 400 nm, or a 50% or more light transmittance of an ultraviolet area at 360 nm.

In the case a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group is reacted with an isocyanate compound having a hardenable reactive group, and is further reacted with an alcohol, a hardenable polymer with a high stability can be obtained. Since a hardenable resin composition is prepared by mixing the hardenable polymer

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A hardenable resin composition of the present invention accordingly obtained is suitable for forming a coloring layer of a color filter, a protection film for covering the coloring layer, and a column-like spacer for maintaining the cell gap of a liquid crystal panel, and thus the coloring layer and the protection film with a desired film thickness, and the column-like spacer with a desired height can be formed accurately.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of an embodiment of a liquid crystal panel.

FIG. 2 is a schematic cross-sectional view of another embodiment of a liquid crystal panel.

FIG. 3 is a graph showing the light transmittance of a photo-curing polymer synthesized in an example.

FIG 4 is a graph showing the light transmittance of a photo-curing polymer synthesized in an example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

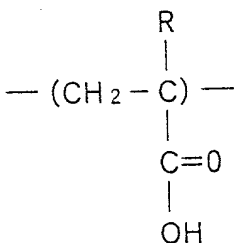
Highly Stable Resin

As an example of a resin capable of improving the stability and prohibiting the thickening phenomenon according

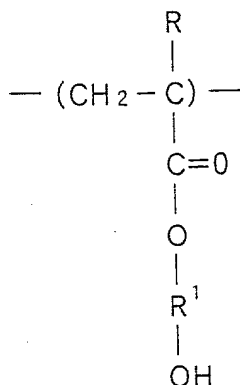
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to the present invention, a photo-curing copolymer resin having a principal chain comprising at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2), with at least a part of the carboxyl group or the hydroxyl group included in the component units bonded with a radical polymerizable group-containing isocyanate compound such as a (meth)acryloyloxy alkyl isocyanate represented by the below-mentioned formula (5) according to reaction of the isocyanate group of the compound can be presented. The (meth)acrylic in the present invention denotes either an acrylic group, or a methacrylic group, and the (meth)acryloyl denotes either an acryloyl group, or a methacryloyl group.

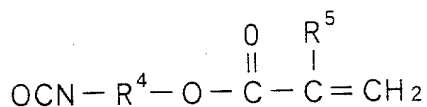
Formula (1)



Formula (2)



Formula (5),



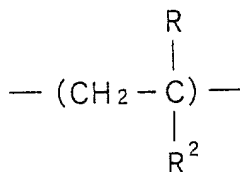
wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, R¹ is an alkylene group having 2 to 4 carbon atoms, R⁴ is an alkylene group, and R⁵ is hydrogen or methyl.

With the copolymer resin presented as an example, the present invention will be explained. The photo-curing copolymer resin preferably contains 5 to 55 mole % of the component unit represented by the formula (1), 5 to 95 mole % of the component unit represented by the formula (2), and 5 to 95 mole % of a radical polymerizable group such as a (meth)acryloyl group, and has 5 to 400 mg KOH/g acidic value, and a 10,000 to 1,000,000 polystyrene-based weight average molecular weight measured by the GPC (gel permeation

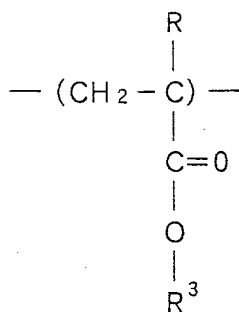
chromatography).

The photo-curing copolymer resin can further contain 0 to 75 mole % of a component unit represented by the below-mentioned formula (3), and 0 to 75 mole % of a component unit represented by the below-mentioned formula (4) as a copolymer component.

Formula (3)



Formula (4)



wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, R² is an aromatic carbon ring, and R³ is an alkyl group or an aralkyl group.

The copolymer component represented by the formula (1) is a component contributing to the alkaline developing property.

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The R included in the formula (1) and the other formulae is hydrogen, or an alkyl group having 1 to 5 carbon atoms. Examples of the alkyl group include a methyl group, an ethyl group, an n-propyl group, an isopropyl group, a n-butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, and a n-pentyl group. As a monomer to be used for introducing the component unit of the formula (1), a compound having a double bond-containing group and a carboxyl group as an acidic functional group can be used. Examples thereof include acrylic acid, methacrylic acid, 2-carboxy-1-butene, 2-carboxy-1-pentene, 2-carboxy-1-hexene, and 2-carboxy-1-heptene. The content of the copolymer component represented by the formula (1) is adjusted according to the alkaline solubility degree demanded to the copolymer resin. In general, it is 5 to 55 mole %, preferably 10 to 25 mole %.

Moreover, the copolymer component represented by the formula (2) is basically a component for introducing a radical polymerizable group therein. The R¹ included in the formula (2) is an alkylene group having 2 to 4 carbon atoms. Examples thereof include an ethylene group, a propylene group, and a butylene group. As a monomer used for introducing the component unit represented by the formula (2), a compound having a double bond-containing group and an hydroxyl group can be used. Examples thereof include 2-hydroxy ethyl acrylate, 2-hydroxy ethyl methacrylate, 2-hydroxy propyl acrylate, 2-hydroxy

propyl methacrylate, 4-hydroxy butyl acrylate, and 4-hydroxy butyl methacrylate. The copolymer component represented by the formula (2) reacts with a radical polymerizable group-containing isocyanate compound via the hydroxyl group for introducing the radical polymerizable group. The content thereof is adjusted according to the photo polymerization degree demanded to the copolymer resin. The content of the copolymer component represented by the formula (2) is 5 to 95 mole % in general, preferably 10 to 50 mole %.

The above-mentioned photo-curing copolymer resin containing the copolymer component represented by the formula (1) and the copolymer component represented by the formula (2) as the essential component may contain other copolymer components. Examples thereof include the copolymer components represented by the formulae (3) and (4).

The copolymer component represented by the formula (3) is a component for providing the film forming property to the copolymer resin at the time of using the copolymer resin for forming a coated film such as a color filter protection film. R^2 is an aromatic carbon ring. Examples thereof include a phenyl group, and a naphthyl group. As a monomer to be used for introducing the component unit represented by the formula (3), a compound having a double bond-containing group and an aromatic carbon ring can be used. Examples thereof include styrene, and α -methyl styrene. Moreover, the aromatic ring

Moreover, the introduction amount of the radical polymerizable group is 5 to 95 mole %, preferably 10 to 50 mole %. With an introduction amount less than 5 mole %, the photo-curing property is low, and thus the effect of improving the coated film adhesion property and the resist characteristics is small.

The above-mentioned photo-curing copolymer resin can be produced by, first, producing a polymer (material polymer) having the component units represented by the formulae (1) to (4), and reacting the same with a radical polymerizable group-containing isocyanate compound.

As a polymerization solvent to be used for producing a polymer having the component units represented by the formulae (1) to (4), a solvent not having active hydrogen, such as a hydroxyl group, and an amino group is preferable. Examples thereof include ethers such as tetrahydro furan, glycol ethers such as diethylene glycol dimethyl ether, diethylene glycol diethyl ether, and diethylene glycol methyl ethyl ether, cellosolve esters such as methyl cellosolve acetate, propylene glycol monomethyl ether acetate, and 3-methoxy butyl acetate. Furthermore, aromatic hydrocarbons, ketones, and esters can also be used.

As a polymerization initiator, those commonly known as a radical polymerization initiator can be used. Specific examples thereof include nitrile-based azo compounds (nitrile-based azo polymerization initiators) such as 2,2'-

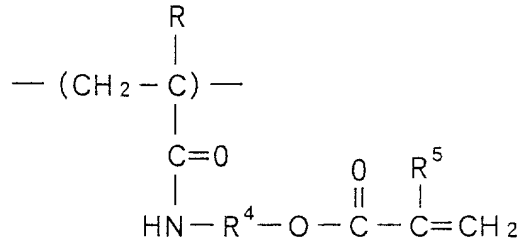
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azobisisobutyronitrile, 2,2'-azobis-(2,4-dimethyl valeronitrile), and 2,2'-azobis-(4-methoxy-2,4-dimethyl valeronitrile); non-nitrile-based azo compounds (non-nitrile-based azo polymerization initiators) such as dimethyl 2,2'-azobis(2-methyl propionate), and 2,2'-azobis(2,4,4-trimethyl pentane); organic peroxides (peroxide-based polymerization initiators) such as t-hexyl peroxy pivalate, tert-butyl peroxy pivalate, 3,5,5-trimethyl hexanoyl peroxide, octanoyl peroxide, lauroyl peroxide, stearoyl peroxide, 1,1,3,3-tetramethyl butyl peroxy 2-ethyl hexanoate, succinic peroxide, 2,5-dimethyl-2,5-di(2-ethyl hexanoyl peroxy) hexane, 1-cyclohexyl-1-methyl ethyl peroxy 2-ethyl hexanoate, t-hexyl peroxy 2-ethyl hexanoate, 4-methyl benzoyl peroxide, benzoyl peroxide, and 1,1'-bis-(tert-butyl peroxy) cyclohexane; and hydrogen peroxide. In the case a peroxide is used as the radical polymerization initiator, it can be used in a combination with a reducing agent as a redox type polymerization initiator.

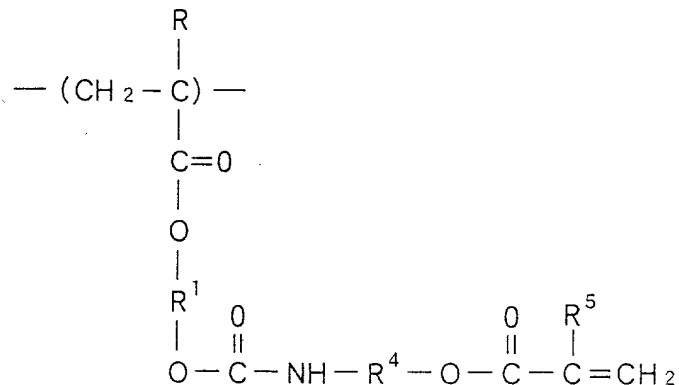
In the production of a polymer having the component units represented by the formulae (1) to (4), a molecular weight adjusting agent can be used for adjusting the weight average molecular weight. Examples thereof include hydrocarbon halides such as chloroform, and carbon tetrabromide; mercaptans such as n-hexyl mercaptan, n-octyl mercaptan, n-dodecyl mercaptan, tert-dodecyl mercaptan, and thio glycol; xanthogens such as dimethyl xanthogen disulfide, and diisopropyl xanthogen

A part of the radical polymerizable group-containing isocyanate compound is bonded with the component unit represented by the formula (1) in the polymer having the component units represented by the formulae (1) to (4) according to amido-bond by discharging carbon dioxide so that a component unit represented by, for example, the below-mentioned formula (6) is formed. In contrast, it is bonded with the component unit represented by the formula (2) according to urethane-bond by addition reaction so that a component unit represented by, for example, the below-mentioned formula (7) is formed.

Formula (6)



Formula (7)



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A photo-curing copolymer resin accordingly obtained has a molecular structure with at least a component unit represented by the formula (1), a component unit represented by the formula (2), a component unit with a radical polymerizable group introduced in a component unit represented by the formula (1), and a component unit with a radical polymerizable group introduced in a component unit represented by the formula (2) interlocked in an optional order.

A radical polymerizable group-containing isocyanate compound has a reaction rate of the reaction with a hydroxyl group in the component unit represented by the formula (2) substantially 20 times as much as that of the reaction with a carboxyl group in the component unit represented by the formula (1). Therefore, the radical polymerizable group is introduced mainly to the component unit represented by the formula (2). And further, even in the case a radical polymerizable group is introduced to a part of the carboxyl group of the component unit represented by the formula (1), most carboxyl groups remain.

The component unit derived from the formula (2) is contained in the copolymer resin by 5 to 95 mole %. In the content, the part not reacted with the isocyanate compound can be 0 to 10 mole %, and the part with the radical polymerizable group introduced can be 5 to 95 mole %. Moreover, the component unit derived from the formula (1) is contained in the copolymer resin by 5 to 55 mole %. In the content, the part not reacted

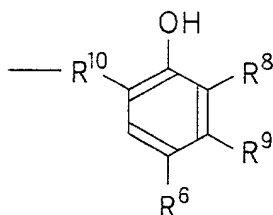
with the isocyanate compound can be 5 to 55 mole %, and the part with the radical polymerizable group introduced can be 0 to 10 mole %, and thus the introduction amount of the radical polymerizable group can be adjusted over a wide range.

In the case the photo-curing copolymer resin is used for forming a coloring layer of a color filter, a protection film for covering the coloring layer, or a column-like spacer for maintaining the cell gap of a liquid crystal panel, it is preferable that the weight average molecular weight is adjusted in the range from 10,000 to 1,000,000, preferably from 20,000 to 100,000. With a weight average molecular weight less than 10,000, the developing property is so good that the pattern shape at the time of pattern exposure can hardly be controlled, or even in the case a pattern can be produced, a problem of reduction of the final film thickness (film reduction) is involved. In contrast, with a weight average molecular weight more than 1,000,000, the viscosity at the time of providing a resist is so high that the coating suitability is deteriorated, and a problem of the developing property deterioration to hinder the pattern formation is involved.

The acidic value of the copolymer resin is 5 to 400 mg KOH/g, preferably 10 to 200 mg KOH/g. The acidic value is related with the alkaline developing property, and thus if the acidic value is too low, a problem of a poor developing property, or a poor adhesion property onto the substrate and a resin of

10 carbon atoms. R^8 is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

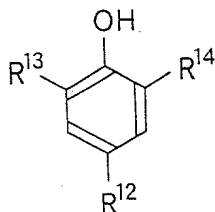
Formula (12)



wherein R^{10} in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R^9 is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R^7 and R^8 is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Among the phenol-based compound represented by the formula (10), those represented by the below-mentioned formulae (13), (14), and (15) are preferable:

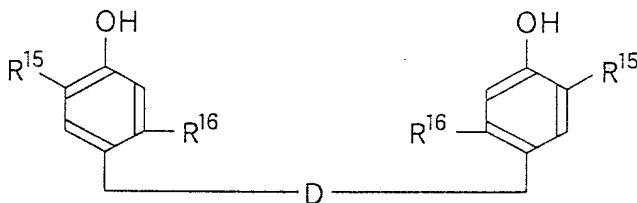
Formula (13)



wherein R^{12} is hydrogen, or an alkyl group having 1 to 5 carbon atoms, and R^{13} and R^{14} are hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R^{13} and R^{14} is a tert-butyl group, or an alkyl group having a cyclohexyl group.

As a specific example corresponding to the above-mentioned formula (13), 3,5-di-tert-butyl-4-hydroxy toluene (BHT) can be presented.

Formula (14)

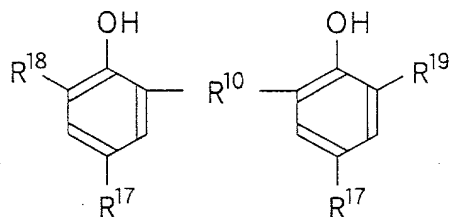


wherein D is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R^{15} is hydrogen or an alkyl group having 1 to 10 carbon atoms. R^{16} is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, substituents of the same numeral can either be same or different. At least one of R^{15} is a tert-butyl group, or an alkyl group having a cyclohexyl group.

As a specific example corresponding to the above-mentioned formula (14), 4,4'-thio-bis(3-methyl-6-tert-butyl

phenol), and 4,4'-butylidene-bis(3-methyl-6-tert-butyl phenol) can be presented.

Formula (15)



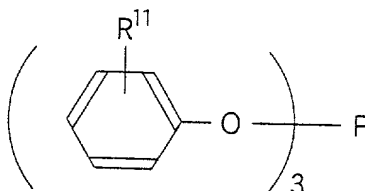
wherein R¹⁰ is an alkyne group having 1 to 10 carbon atoms or an alkyldiene group having 1 to 10 carbon atoms. R¹⁷ is hydrogen or an alkyl group having 1 to 5 carbon atoms. R¹⁸ and R¹⁹ are hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R¹⁸ and R¹⁹ is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

As a specific example corresponding to the above-mentioned formula (15), 2,2'-methylene-bis(4-methyl-6-tert-butyl phenol), 2,2'-methylene-bis(4-ethyl-6-tert-butyl phenol), and 2,2'-dihydroxy-3,3'-di(α-methyl-cyclohexyl)-5,5'-dimethyl diphenyl methane can be presented.

The specific phosphite-based polymerization inhibitor capable of improving the transparency of the photo-curing copolymer resin can be represented by the below-mentioned

formula (16):

Formula (16)



wherein R¹¹ is hydrogen or an alkyl group having 1 to 20 carbon atoms.

As a specific example corresponding to the above-mentioned formula (16), tris(nonylated phenyl)phosphite can be presented.

In particular, by reacting a material polymer preliminarily produced using the above-mentioned specific polymerization initiator with a radical polymerizable group-containing isocyanate compound using the above-mentioned specific polymerization inhibitor, the excellent transparency can be obtained.

In the case a photo-curing copolymer resin is synthesized using the above-mentioned specific polymerization initiator and/or the above-mentioned specific polymerization inhibitor, since coloring of the obtained reaction liquid is slight, the refining step for eliminating the coloring component from the photo-curing copolymer resin can be

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simplified or completely eliminated. Therefore, the reaction liquid containing the photo-curing copolymer resin as it is without refining can be used as a coating liquid for forming a pattern required to have the transparency, such as a coloring layer of a color filter or a protection film. For example, the reaction liquid containing the photo-curing copolymer resin of the present invention is diluted in a 3-methoxy butyl acetate as it is or the photo-curing copolymer resin separated from the reaction liquid is dissolved in a 3-methoxy butyl acetate so as to prepare a 3-methoxy butyl acetate solution of a 20% by weight resin solid component. The prepared solution placed in a 1 cm square quartz cell shows the excellent transparency of a 60% or more light transmittance at 400 nm, preferably 70% or more.

This kind of photo-curing resins tend to have the light transmittance lower in the vicinity of 480 nm so as to show the local minimum point of the light transmittance. However, the transparent photo-curing copolymer resin obtained in the present invention does not show the drop of the light transmittance, and has a 85% or more, preferably 90% or more light transmittance in the vicinity of 480 nm under the above-mentioned measurement condition.

The photo-curing copolymer resin obtained in the present invention shows a high light transmittance in the entire area of a visible light. In the measurement under the

of 360 nm is high, the function of the photo polymerization initiator is promoted so that the exposure sensitivity can further be improved.

Since the above-mentioned photo-curing copolymer resin can adjust the content of the alkaline soluble group and the radical polymerizable group in the resin over a wide range, it can be utilized preferably as the effective component of a photo resist. In particular, it is suited for forming a coloring layer of a color filter, a protection film for covering the coloring layer or a column-like spacer for maintaining the cell gap of a liquid crystal panel.

However, if the photo-curing copolymer resin is dissolved or dispersed in a solvent, the molecular amount is increased even in a room temperature so as to rapidly raise the viscosity. If the photo-curing copolymer resin mixed with an epoxy resin, an acrylic monomer, or a polymerization initiator is dissolved or dispersed in a solvent for preparing a photo resist, the degree and the rate of thickening is further remarkable.

Initially, the present inventors considered that a radical polymerizable group such as a (meth)acryloyl group existing in the photo-curing copolymer resin not only relates to the hardening reaction in exposure but also gives rise to the thickening increase in storage. However, according to observation of a solution of the above-mentioned photo-curing

copolymer resin by the ^1H -NMR spectrum, it is confirmed that the double bond amount of the (meth)acryloyl group is not reduced even if the viscosity of the solution rises. Therefore, the radical polymerization group is not the cause of the thickening increase.

Then, the above-mentioned solution of the photo-curing copolymer resin was observed by the FT-IR spectrum (infrared ray absorption spectrum) so that it is confirmed that a minute peak in the vicinity of $1,800\text{ cm}^{-1}$ vanishes according to the viscosity rise. In consideration of the observation result, the FT-IR spectrum of an acrylic anhydride was observed so that a peak was observed at the same position. Moreover, by reacting acetic acid which has a carboxyl group as well as the acrylic acid with a (meth)acryloyloxy ethyl isocyanate, an acid anhydride was obtained.

From these results, the above-mentioned photo-curing copolymer resin is considered to have an acid anhydride group. The acid anhydride group is assumed to be generated as a side product according to dehydration condensation of a part of the component unit represented by the formula (1) in the same molecule as a result of the function of the isocyanate group as a dehydrating agent at the time of producing the photo-curing copolymer resin by reaction of a polymer having at least the component units represented by the formulae (1) and (2) with the radical polymerizable group-containing isocyanate

compound. Moreover, by dissolving or dispersing the polymer in a solvent and leaving, the acid anhydride group generated in the molecule of the photo-curing copolymer resin is assumed to react with a hydroxyl group of the component unit represented by the formula (2) contained in another molecule of the photo-curing copolymer resin so as to ester-bond and cross-link the molecules in the photo-curing copolymer resin, resulting in the molecular weight increase and the viscosity rise.

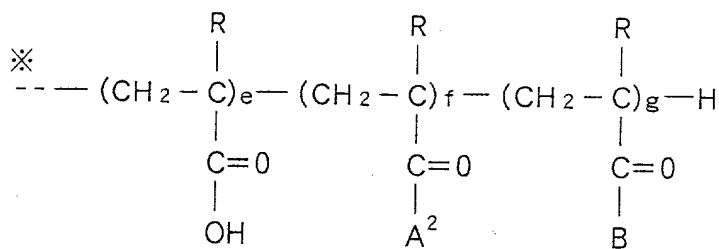
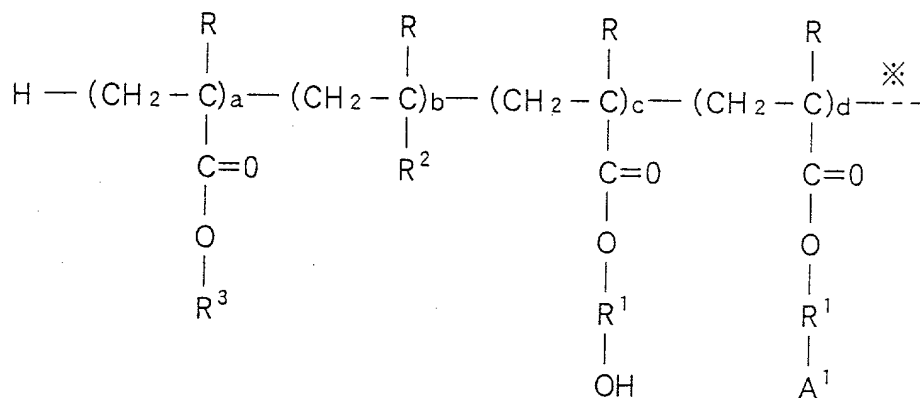
The thickening phenomenon can be prohibited by the alcohol treatment of the above-mentioned photo-curing copolymer resin. For treating the photo-curing copolymer resin with an alcohol, the alcohol can be added to a solution with the above-mentioned photo-curing copolymer resin dissolved or dispersed in a solvent before viscosity rise of the solution or before completion of viscosity rise of the solution. Moreover, it is also possible to polymerize the monomers in a solvent for synthesis such as MBA (3-methoxy butyl acetate, $\text{CH}_3\text{CH}(\text{OCH}_3)\text{CH}_2\text{CH}_2\text{OCOCH}_3$) so as to synthesize a material copolymer having at least the component units represented by the formulae (1) and (2), drop a radical polymerizable group-containing isocyanate compound into a solution of the obtained polymer for reaction, and subsequently add an alcohol to the obtained reaction liquid. The reaction condition at the time of addition is not particularly limited, and the alcohol

can be added when the reaction liquid is hot or it is at a room temperature, or can be added into the reaction liquid at on time.

In the case an alcohol is added to the above-mentioned solution of the photo-curing copolymer resin when the acid anhydride group is still unreacted, the alcohol is assumed to compete with the hydroxyl group of the component unit represented by the formula (2) for getting the acid anhydride group so as to esterify the acid anhydride group. As a result, the cross-linking reaction among the photo-curing copolymer resin molecules is prohibited so that the molecular weight increase and the viscosity rise can be prevented.

The molecular structure of the alcohol treatment polymer obtained by adding an alcohol to the above-mentioned photo-curing copolymer resin can be represented by the below-mentioned formula (8):

Formula (8)



wherein R, R¹, R² and R³ are same as the above-mentioned, A¹ is a residual group of the urethane-bond of the radical polymerizable group-containing isocyanate compound, A² is a residual group of the amido-bond of the radical polymerizable group-containing isocyanate compound, and B is a residual group

of the ester-bond of the alcohol. Moreover, a, b and c denote an integer of 0 or more, and d, e, f and g denote an integer of 1 or more. The component units can either be random-copolymerized, or block-copolymerized.

In the present invention, the reaction with the alcohol should be carried out when a part or the entirety of the acid anhydride groups remains unreacted in the copolymer resin. For example, since the acid anhydride group is not reacted with the hydroxyl group represented by the formula (2) at all immediately after production of the photo-curing copolymer resin by reacting a material polymer having at least the component units represented by the formulae (1) and (2) with the radical polymerizable group-containing isocyanate compound, and thus the viscosity rise is not started, it can be reacted with the alcohol added from the outside. Moreover, even after leaving the solution of the photo-curing copolymer resin at a room temperature for a while, since the unreacted acid anhydride group remains in the case the viscosity rise is still proceeding and not finished completely, the viscosity rise can be prohibited to a certain degree, and thus it is effective.

The kind of the alcohol to be used for prohibiting the thickening phenomenon is not particularly limited, and a compound having an alcoholic hydroxyl group can be used. It can also contain atoms of N, O, S, P, or the like. In general,

those having a relatively low molecular weight can easily be handled. For example, those having about 1 to 20 carbon atoms and containing or not containing N, O, S, P, or the like can be presented. More specifically, alcohol-based solvents, such as methanol, ethanol, propanol, butanol, pentanol, hexanol, heptanol, octanol, and decanol; cellosolve-based solvents, such as methoxy alcohol, and ethoxy alcohol; carbitol-based solvents such as methoxy ethoxy ethanol, and ethoxy ethoxy alcohol; ether-based solvents, such as ethylene glycol monomethyl ether, diethylene glycol monomethyl ether, ethylene glycol monopropyl ether, and propylene glycol monomethyl ether; and unsaturated bond-containing solvents, such as 2-hydroxyethyl(meth)acrylate, 2-hydroxypropyl(meth)acrylate, 2-hydroxybutyl(meth)acrylate, 4-pentene-1-ol, tetramethylol methane tri(meth)acrylate, tetratrimethylol propane tri(meth)acrylate, and dipentaerythritol hexaacrylate can be used.

Furthermore, the unreacted alcohol remaining in the solvent of the photo-curing copolymer resin can be eliminated as needed by an appropriate means such as the reprecipitation refining. Moreover, it is also possible to add the alcohol to the solution of the photo-curing copolymer resin, mix the same as it is with other materials in a solvent (a coating solvent) for providing a coating liquid, and evaporate the same with the coating solvent in the drying step after the coating operation.

10 to 120% by weight with respect to the photo-curing copolymer resin.

In order to substantially completely stopping the viscosity rise of the solution of the photo-curing copolymer resin, it is necessary to leave the reaction liquid for a certain time after addition of the alcohol for sufficiently reducing the amount of the acid anhydride group, and maturing the alcohol process polymer. The reaction liquid can be left in a room temperature, but the maturation can be completed in a shorter time by heating. It is preferable that the reaction liquid with the alcohol added is matured by leaving at 30 to 170 °C for a period within 72 hours.

For example, if the maturation time at 90 °C is less than 4 hours, the resin cannot be stabilized completely, and thus the thickening prevention effect is insufficient.

As mentioned above, by adding an alcohol to a solution of a photo-curing copolymer resin having a principal chain including at least a component unit represented by the formula (1) and a component unit represented by the formula (2), with a radical polymerizable group-containing isocyanate compound bonded at least to a part of a carboxyl group or a hydroxyl group contained in the component units via an isocyanate group of the isocyanate compound, the thickening phenomenon can be prohibited so that a highly stable improved resin with a part of the carboxylic acid group of the resin esterified can be

obtained.

Furthermore, according to the present invention, by reacting a material polymer including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound not having a radical polymerizable group, and reacting the obtained polymer with an alcohol, like the above-mentioned case of treating the photo-curing copolymer with an alcohol, the molecular amount increase of the polymer, and the viscosity rise of the solution can be prohibited so that a highly stable resin can be obtained.

By reacting a material polymer including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, a polymer with the isocyanate compound amido-bonded with at least a part of the acidic functional group via an isocyanate group and/or urethane-bonded with at least a part of the hydroxyl group can be obtained. Like the above-mentioned photo-curing copolymer resin, a polymer having such a molecular structure is considered to provide an acid anhydride group as a side product by dehydration condensation of a part of the acidic functional group in the polymer molecule according to function of the isocyanate compound. If the polymer is dissolved or dispersed in a solvent and left, the cross-linking reaction among the molecules takes place in the same principle as the above-mentioned photo-curing copolymer resin so that the

Table 1. Demographic characteristics of the study population	
Age (years)	50.0 ± 10.0
Gender	
Male	50.0%
Female	50.0%
Education (years)	12.0 ± 2.0
Marital status	
Married	80.0%
Single	20.0%
Occupation	
Professional	30.0%
Managerial	20.0%
Technical	10.0%
Skilled	20.0%
Unskilled	20.0%
Income (USD/month)	1,500.0 ± 500.0
Health status	
Good	70.0%
Fair	20.0%
Poor	10.0%

[illegible]

Table 1. Demographic characteristics of the study population	
Age (years)	65.2 (SD 10.5)
Gender	
Male	55.2%
Female	44.8%
Education (years)	12.5 (SD 2.1)
Marital status	
Married	68.5%
Widowed	21.3%
Divorced	8.2%
Single	1.0%
Income (USD/month)	1,250 (SD 350)
Health status	
Good	72.5%
Fair	18.7%
Poor	8.8%
Functional status	
Independent	85.3%
Dependent	14.7%
Comorbidities	
Hypertension	45.2%
Diabetes	32.1%
Heart disease	28.9%
Stroke	15.6%
Arthritis	38.4%
Chronic lung disease	12.3%
Depression	22.7%
Alcohol use	
Regular	10.5%
Occasional	25.3%
Never	64.2%
Smoking status	
Current	18.9%
Former	35.7%
Never	45.4%

[illegible]

reactive group, a radical polymerizable group such as a (meth)acryloyl group can be introduced into the isocyanate compound as mentioned above.

In the case a highly stable resin is required to have the excellent transparency in the visible area or the excellent light transmittance in the ultraviolet area, like the above-mentioned case of producing a photo-curing copolymer resin, it is preferable to use a non-nitrile-based azo or peroxide-based polymerization initiator, or to use a phenol-based polymerization inhibitor represented by the above-mentioned formula (10) or a phosphite-based polymerization inhibitor represented by the above-mentioned formula (16). That is, by carrying out the polymerization reaction using a non-nitrile-based azo polymerization initiator or a peroxide-based polymerization initiator at the time of forming a material polymer, that is, the principal chain part of a highly stable resin by reacting a monomer having a double bond-containing group and an acidic functional group, a monomer having a double bond-containing group and a hydroxyl group, and optionally another monomer as needed, the transparency and the ultraviolet ray transmittance of the obtained reaction liquid can be improved. Moreover, also by using a polymerization inhibitor selected from the group consisting of compounds represented by the above-mentioned formulae (10) and (16) at the time of reacting the material

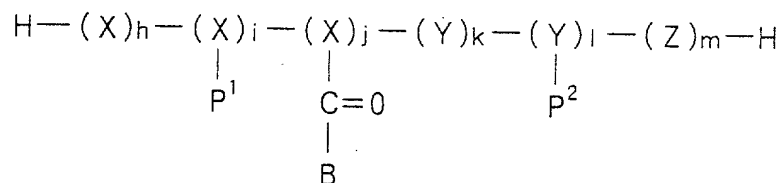
more, or a 50% or more light transmittance in the ultraviolet area, preferably 60% or more.

A polymerization intermediate obtained by reacting a material polymer with an isocyanate compound can be applied with the alcohol treatment in the same procedure as in the above-mentioned case of the photo-curing copolymer. That is, by adding an alcohol to a reaction liquid obtained by the reaction of the material polymer and the isocyanate compound, or a solution obtained by dissolving or dispersing the polymer refined from the reaction liquid again in a solvent before viscosity rise or before completion of viscosity rise, a highly stable polymer can be obtained. Moreover, the polymer applied with the alcohol treatment is left or heated for a predetermined time for maturation as needed.

The alcohol treated polymer thus obtained has a molecular structure with a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group, wherein an isocyanate compound is amido-bonded with at least a part of the acidic functional group via an isocyanate group of the isocyanate compound and/or urethane-bonded with at least a part of the hydroxyl group via an isocyanate group of the isocyanate compound, and an alcohol is ester-bonded with at least a part of the acidic functional group via a hydroxyl group of the alcohol. The molecular structure can be represented by the

1. Age and sex		2. Education		3. Income		4. Health		5. Employment		6. Social capital		7. Life satisfaction		8. Well-being	
1.1 Age	1.2 Sex	2.1 Education	2.2 Literacy	3.1 Income	3.2 Poverty	4.1 Health	4.2 Disability	5.1 Employment	5.2 Unemployment	6.1 Social capital	6.2 Trust	7.1 Life satisfaction	7.2 Well-being	8.1 Well-being	8.2 Well-being
1.1.1 Age	1.1.2 Sex	2.1.1 Education	2.1.2 Literacy	3.1.1 Income	3.1.2 Poverty	4.1.1 Health	4.1.2 Disability	5.1.1 Employment	5.1.2 Unemployment	6.1.1 Social capital	6.1.2 Trust	7.1.1 Life satisfaction	7.1.2 Well-being	8.1.1 Well-being	8.1.2 Well-being
1.1.1.1 Age	1.1.1.2 Sex	2.1.1.1 Education	2.1.1.2 Literacy	3.1.1.1 Income	3.1.1.2 Poverty	4.1.1.1 Health	4.1.1.2 Disability	5.1.1.1 Employment	5.1.1.2 Unemployment	6.1.1.1 Social capital	6.1.1.2 Trust	7.1.1.1 Life satisfaction	7.1.1.2 Well-being	8.1.1.1 Well-being	8.1.1.2 Well-being

Formula (9)



wherein X is a component unit having an acidic functional group, Y is a component unit having a hydroxyl group, Z is another component unit, P¹ is a residual group of the amido-bonded isocyanate compound, P² is a residual group of the urethane-bonded isocyanate compound, and B is a residual group of the ester-bonded alcohol. Moreover, k, m are an integer of 0 or more, and h, i, j, l are an integer of 1 or more.

Hardenable Resin Composition

After reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound having a hardenable reactive group such as a photo-curing group or a thermosetting group, by further reacting the same with an alcohol, a hardenable polymer with a high stability can be obtained. Various hardenable polymers can be obtained depending on the kind of the hardenable group to be introduced into the isocyanate compound. The

ethyl(meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, pentyl(meth)acrylate, ethylhexyl(meth)acrylate, styrene, methyl styrene, and N-vinyl pyrrolidone can be added as a reaction diluting agent.

The content of the polyfunctional acrylate-based monomer as a photo polymerizable monomer in the photo-curing resin composition is 3 to 50% by weight, preferably 5 to 40% by weight by the solid component ratio. With the polyfunctional acrylate-based monomer by less than 3% by weight, a problem arises in that the physical strengths of the film to be formed, such as the bonding strength, and the heat resistance are insufficient. In contrast, with a ratio more than 50% by weight, the stability of the photo-curing resin composition is deteriorated as well as the flexibility of the film to be formed is insufficient. Furthermore, the ratio is important also for improving the dissolving characteristics with respect to the developing liquid. In the case it is outside the range of the optimum amount, even though the pattern resolution is possible, the monomer hardening rate is high so that the scum and the beard are generated in the periphery of the pattern. Moreover, at the outside the above-mentioned range, in a terrible case, resist re-adhesion derived from partial swelling and peel-off is generated so as to inhibit the accurate pattern formation.

Furthermore, in the photo-curing resin composition according to the present invention, a compound having two or

more epoxy groups in molecule (epoxy resin) can be included as needed for improving the heat resistance, the adhesion property, the chemical resistance (in particular, the alkaline resistance). Examples of the compound having two or more epoxy groups in a molecule include bisphenol A type epoxy resins, such as Epi Coat 1001, 1002, 1003, 1004, 1007, 1009, and 1010 (produced by Yuka Shell Corp.), bisphenol F type epoxy resins, such as Epi Coat 807 (produced by Yuka Shell Corp.), phenol novolak type epoxy resins, such as EPPN 201, 202 (produced by Nihon Kayaku Corp.), and Epi Coat 154 (produced by Yuka Shell Corp.), and cresol novolak type epoxy resins, such as EOCN 102, 103S, 104S, 1020, 1025, 1027 (produced by Nihon Kayaku Corp.), and Epi Coat 180S (produced by Yuka Shell Corp.). Furthermore, cyclic aliphatic epoxy resin and aliphatic polyglycidyl ethers can be presented as well.

Among these examples, the bisphenol A type epoxy resins, the bisphenol F type epoxy resins, the phenol novolak type epoxy resins, and the cresol novolak type epoxy resins are preferable. Although most of the compounds having two or more epoxy groups in a molecule have a high molecular weight, the glycidyl ethers such as bisphenol A and bisphenol F have a low molecular weight, and those having a low molecular weight are particularly preferable. Moreover, an acrylic copolymer including glycidyl(meth)acrylate, oxetane(meth)acrylate, alicyclic epoxy(meth)acrylate, or the like, in a resin skeleton is also

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chlorosulfonyl, chloromethyl polynuclear aromatic compounds, chloromethyl heterocyclic compounds, and chloromethyl benzophenone; triadines; fluorenones; haloalkanes; redox couples of a photo reducing pigment and a reducing agent; organic sulfur compounds; and peroxides. Preferably, ketone-based and biimidazol-based compounds, such as Irgacure 184, Irgacure 369, Irgacure 651, Irgacure 907 (produced by Chiba Specialty Chemicals Corp.), Darocure (produced by Merc Corp.), Adeka 1717 (produced by Asahi Denka Kogyo Corp.), and 2,2'-bis(o-chloro phenyl)-4,5,4'-tetra phenyl-1,2'-biimidazol (produced by Kurogane Kasei Corp.) can be presented. The initiators can be used alone or in a combination of two or more. In the case of using two or more, it is preferable not to prohibit the absorption spectrum characteristics.

The radical polymerization initiator is contained in the photo-curing resin composition by, in general, 0.1 to 20% by weight, preferably 1 to 15% by weight by the solid component ratio. With a less than 0.1% by weight radical polymerization initiator addition amount, the photo-curing reaction is not proceeded so that the residual film ratio, the heat resistance, and the chemical resistance tend to be lowered. Moreover, with a more than 20% by weight addition amount, the solubility to the base resin is saturated so that crystals of the initiator are precipitated at the time of spin coating or coated film leveling so as not to maintain the homogeneity of the film

surface, and thus a problem of the film ruggedness generation is involved.

In adjusting the photo-curing resin composition, the polymerization initiator may be added initially to the resin composition including the above-mentioned polyfunctional acrylate-based monomer and the hardenable polymer, but in the case of a relatively long term storage, it is preferable to disperse or dissolve the same in the resin composition immediately before use.

In the case improvement of the light sensitivity is required, a sensitizer may be added. As the sensitizer to be used, a styryl-based compound or a coumarin-based compound is preferable. Specifically, 2-(p-dimethyl amino styryl) quinoline, 2-(p-diethyl amino styryl) quinoline, 4-(p-dimethyl amino styryl) quinoline, 4-(p-diethyl amino styryl) quinoline, 2-(p-dimethyl amino styryl)-3,3-3H-indol, 2-(p-diethyl amino styryl)-3,3-3H-indol, 2-(p-dimethyl amino styryl) benzoxazol, 2-(p-diethyl amino styryl)-benzoxazol, 2-(p-dimethyl amino styryl)benzimidazol, and 2-(p-diethyl amino styryl)-benzimidazol can be presented.

Moreover, as the coumarin-based compounds, 7-diethyl amino-4-methyl coumarin, 7-ethyl amino-4-trifluoro methyl coumarin, 4,6-diethyl amino-7-ethyl amino coumarin, 3-(2-benzimidazolyl)-7-N,N-diethyl amino coumarin, 7-diethyl amino cyclopenta (c) coumarin, 7-amino-4-trifluoro methyl

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courmarin, 1,2,3,4,5,3H, 6H, 10H-tetra hydro-8-trifluoro methyl (1) benzopyrrano-(9,9a,1-gh)-quinolidine-10-on, 7-ethyl amino-6-methyl-4-trifluoro methyl courmarin, and 1,2,3,4,5,3H,6H,10H-tetra hydro-9-carbethoxy (1) benzopyrrano-(9,9a,1-gh)-quinolidine-10-on can be presented.

To the above-mentioned photo-curing resin composition, various additives, such as the below-mentioned surfactants and silane coupling agents can be added as needed.

The surfactants are added to the photo-curing resin composition for ensuring the coating suitability, and the film flatness after drying. Examples thereof include polyoxy ethylene alkyl ethers such as polyoxy ethylene lauryl ether, polyoxy ethylene stearyl ether, and polyoxy ethylene oleyl ether, polyoxy ethylene aryl alkyl ethers such as polyoxy ethylene octyl phenyl ether, and polyoxy ethylene nonyl phenyl ether, polyoxy ethylene dialkyl esters such as polyoxy ethylene dilaurate, and polyoxy ethylene distearate, and fluorine-based surfactants such as Megafac F171, 172, 173 (produced by Dainippon Ink Corp.), Florade FC430, 431 (produced by Sumitomo 3M Corp.), Asahi Guard AG710, Surflone S-382, SC-101, 102, 103, 104, and 105(Asahi glass Corp.) The content of the surfactant is preferably 2 parts by weight or less with respect to 100 parts by weight of the solid component of the photo-curing resin composition, and more preferably 1 part by weight or less.

Moreover, the silane coupling agents are added for

improving the adhesion property to the adjacent substrates or another coating layer. For example, vinyl silanes, acrylic silanes, epoxy silanes, and amino silanes can be presented. More specifically, as a vinyl silane, vinyl trichlorsilane, vinyl tris(β -methoxy ethoxy) silane, vinyl triethoxy silane, vinyl trimethoxy silane, or the like, can be used. Furthermore, as an acrylic silane, γ -methacryloxy propyl trimethoxy silane, γ -methacryloxy propyl methyl dimethoxy silane, or the like, can be used. As an epoxy silane, β -(3,4-epoxy cyclo hexyl) ethyl trimethoxy silane, γ -glycidoxy propyl trimethoxy silane, γ -glycidoxy propyl methyl diethoxy silane, or the like, can be used. Furthermore, as an amino silane, N- β -(amino ethyl)- γ -amino propyl trimethoxy silane, N- β -(amino ethyl)- γ -amino propyl methyltrimethoxy silane, γ -amino propyl triethoxy silane, N-phenyl- γ -amino propyl trimethoxy silane, or the like, can be used. As other silane coupling agents, γ -mercaptopropyl trimethoxy silane, γ -chloropropyl trimethoxy silane, γ -chloropropyl methyl dimethoxy silane, γ -chloro propyl methyl diethoxy silane, or the like, can be used.

In the present invention, in general, a solvent is contained in the above-mentioned photo-curing resin composition or another hardenable resin composition in consideration of preparation of a paint and the coating suitability. As a usable solvent, for example, organic solvents including alcohol-based solvents such as methyl

solvents such as methyl methoxy propionate, ethyl ethoxy propionate, and ethyl lactate can be used particularly preferably. Particularly preferably, MBA (3-methoxy butyl acetate, $\text{CH}_3\text{CH}(\text{OCH}_3)\text{CH}_2\text{CH}_2\text{OCOCH}_3$), PGMEA (propylene glycol monomethyl ether acetate, $\text{CH}_3\text{OCH}_2\text{CH}(\text{CH}_3)\text{OCOCH}_3$), DMDG (diethylene glycol dimethyl ether, $\text{H}_3\text{COC}_2\text{H}_4\text{OCH}_3$), or a mixture thereof can be used. The solid component concentration is adjusted to 5 to 50% by weight, using these solvents.

As a method for producing a highly stable photo-curing resin composition, first, monomers are reacted in a solvent for synthesis (a synthesis solvent) such as the above-mentioned MBA (3-methoxy butyl acetate) to synthesize a material polymer. Then, a radical polymerizable group-containing isocyanate compound is dropped into a solution of the obtained material polymer for reaction so as to produce a photo-curing polymer. In the case the transparency of the resin is particularly required, the material polymer is produced using a non-nitrile-based azo polymerization initiator or a peroxide-based polymerization initiator as well as a radical polymerizable group-containing isocyanate compound is introduced using a polymerization inhibitor selected from the group consisting of the compounds represented by the above-mentioned formulae (10) and (16). Then, an alcohol is added to a reaction liquid containing the photo-curing polymer, and the photo-curing polymer applied with the alcohol treatment is matured by, for

example, heating at 30 to 170°C within 72 hours. The reaction liquid is mixed with a resist solvent such as MBA, PGMEA, and DMDG with other resist materials. The solid component concentration in the photo-curing resin composition is in general, in the range of 5 to 85% by weight.

In the case a hardenable polymer mixed with another coating material is dissolved or dispersed in a solvent, the thickening phenomenon is further remarkable compared with the case of a solution of the hardenable polymer alone. Therefore, in the case of preparing a hardenable resin composition with a hardenable polymer mixed with another material, it is particularly preferable to mix the hardenable polymer with the other material after sufficient maturation by leaving or heating for a predetermined time after the alcohol treatment.

It is preferable that the alcohol to be reacted with the hardenable polymer has a boiling point or an evaporation rate close to that of the solvent for preparing a coating liquid. It is more preferable that both boiling point and evaporation rate are close to those of the coating liquid solvent. More specifically, it is preferable that the difference of the alcohol boiling point and the coating liquid solvent boiling point is within 75 °C, in particular, within 40 °C, and/or the difference of the alcohol evaporation rate and the coating liquid solvent evaporation rate is within 90[n-BuOAc=100], in particular, within 30[n-BuOAc=100]. In the case the boiling

Descriptive Statistics		ANOVA		Post Hoc		Correlation		Regression	
Variable	Mean	SD	F	p	Pairwise	r	Model	Adjusted R ²	Model
Dependent Variable	1.23	0.45	12.34	0.001	0.05	0.65	0.75	0.65	0.75
Independent Variable 1	2.34	0.56	1.23	0.28	0.05	0.45	0.55	0.55	0.55
Independent Variable 2	3.45	0.67	2.34	0.12	0.05	0.56	0.66	0.66	0.66
Independent Variable 3	4.56	0.78	3.45	0.05	0.05	0.67	0.77	0.77	0.77
Independent Variable 4	5.67	0.89	4.56	0.01	0.05	0.78	0.88	0.88	0.88
Independent Variable 5	6.78	0.90	5.67	0.00	0.05	0.89	0.99	0.99	0.99
Independent Variable 6	7.89	0.91	6.78	0.00	0.05	0.90	1.00	1.00	1.00
Independent Variable 7	8.90	0.92	7.89	0.00	0.05	0.91	1.00	1.00	1.00
Independent Variable 8	9.01	0.93	8.90	0.00	0.05	0.92	1.00	1.00	1.00
Independent Variable 9	9.12	0.94	9.01	0.00	0.05	0.93	1.00	1.00	1.00
Independent Variable 10	9.23	0.95	9.12	0.00	0.05	0.94	1.00	1.00	1.00
Independent Variable 11	9.34	0.96	9.23	0.00	0.05	0.95	1.00	1.00	1.00
Independent Variable 12	9.45	0.97	9.34	0.00	0.05	0.96	1.00	1.00	1.00
Independent Variable 13	9.56	0.98	9.45	0.00	0.05	0.97	1.00	1.00	1.00
Independent Variable 14	9.67	0.99	9.56	0.00	0.05	0.98	1.00	1.00	1.00
Independent Variable 15	9.78	1.00	9.67	0.00	0.05	0.99	1.00	1.00	1.00
Independent Variable 16	9.89	1.01	9.78	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 17	9.90	1.02	9.89	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 18	9.91	1.03	9.90	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 19	9.92	1.04	9.91	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 20	9.93	1.05	9.92	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 21	9.94	1.06	9.93	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 22	9.95	1.07	9.94	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 23	9.96	1.08	9.95	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 24	9.97	1.09	9.96	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 25	9.98	1.10	9.97	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 26	9.99	1.11	9.98	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 27	10.00	1.12	9.99	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 28	10.01	1.13	10.00	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 29	10.02	1.14	10.01	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 30	10.03	1.15	10.02	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 31	10.04	1.16	10.03	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 32	10.05	1.17	10.04	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 33	10.06	1.18	10.05	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 34	10.07	1.19	10.06	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 35	10.08	1.20	10.07	0.00	0.05	1.00	1.00	1.00	1.00
Independent Variable 36	10.09	1.21	10.						

[illegible]

Descriptive Statistics		ANOVA		Post Hoc	
Variable	Mean (SD)	F	p	Comparison	Effect Size
Age	35.2 (12.5)	1.2	.31		
Gender	Male: 55, Female: 45	0.5	.48		
Education	12.8 (1.5)	0.8	.52		
Income	\$32,000 (15,000)	1.5	.23		
Marital Status	Married: 60, Single: 40	0.2	.63		
Employment	Full-time: 50, Part-time: 50	0.1	.74		
Health Status	Good: 65, Fair: 35	0.3	.58		
Stress Level	Low: 40, High: 60	1.8	.18		
Sleep Quality	Good: 55, Poor: 45	2.1	.15		
Dietary Habits	Healthy: 60, Unhealthy: 40	1.4	.24		
Exercise Frequency	Regular: 50, Irregular: 50	0.9	.34		
Alcohol Consumption	Low: 55, High: 45	1.1	.30		
Tobacco Use	Non-user: 60, User: 40	0.4	.53		
Family Size	1-2: 50, 3+: 50	0.6	.43		
Work-Life Balance	Good: 55, Poor: 45	1.3	.26		
Life Satisfaction	High: 50, Low: 50	2.5	.12		
Resilience Score	High: 55, Low: 45	1.7	.19		
Emotional Stability	Stable: 60, Unstable: 40	1.0	.32		
Self-Esteem	High: 55, Low: 45	1.6	.21		
Optimism	Optimistic: 50, Pessimistic: 50	0.7	.40		
Gratitude	Grateful: 55, Not Grateful: 45	1.2	.28		
Forgiveness	Forgiving: 50, Not Forgiving: 50	0.9	.34		
Empathy	High: 55, Low: 45	1.4	.24		
Compassion	Compassionate: 50, Not Compassionate: 50	0.8	.38		
Kindness	Kind: 55, Not Kind: 45	1.1	.30		
Patience	Patient: 50, Impatient: 50	0.6	.43		
Humility	Humble: 55, Not Humble: 45	1.3	.26		
Modesty	Modest: 50, Not Modest: 50	0.5	.48		
Generosity	Generous: 55, Not Generous: 45	1.0	.32		
Generosity	Generous: 55, Not Generous: 45	1.0	.32		

Descriptive Statistics		ANOVA		Post Hoc		Correlation		Regression	
Variable	Mean	SD	F	p	Pairwise	r	Model	Adjusted R ²	Standard Error
Dependent Variable	10.5	2.5	12.3	.001	10.5 vs 12.5	.75	1.2	.85	1.5
Independent Variable	5.0	1.5	1.5	.21	5.0 vs 6.5	.45	.8	.75	1.2
Control Variable	3.0	1.0	0.5	.48	3.0 vs 4.0	.20	.5	.60	.8
Interaction	2.0	1.0	0.2	.63	2.0 vs 3.0	.10	.3	.40	.5
Quadratic	1.0	0.5	0.1	.74	1.0 vs 2.0	.05	.2	.30	.4
Cubic	0.5	0.2	0.0	.95	0.5 vs 1.0	.02	.1	.20	.3
Quartic	0.2	0.1	0.0	.98	0.2 vs 0.5	.01	.0	.10	.2
Quintic	0.1	0.0	0.0	.99	0.1 vs 0.2	.00	.0	.05	.1
Sixth	0.0	0.0	0.0	1.00	0.0 vs 0.1	.00	.0	.00	.0
Seventh	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Eighth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Ninth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Tenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Eleventh	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twelfth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Fourteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Fifteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Sixteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Seventeenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Eighteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Nineteenth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twentieth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-first	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-second	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-third	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-fourth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-fifth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-sixth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-seventh	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-eighth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Twenty-ninth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirtieth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-first	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-second	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-third	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-fourth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-fifth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-sixth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-seventh	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0
Thirty-eighth	0.0	0.0	0.0	1.00	0.0 vs 0.0	.00	.0	.00	.0</

a) α -methylbenzylamine		b) α -methylbenzylamine		c) α -methylbenzylamine		d) α -methylbenzylamine		e) α -methylbenzylamine		f) α -methylbenzylamine		g) α -methylbenzylamine		h) α -methylbenzylamine		i) α -methylbenzylamine		j) α -methylbenzylamine		k) α -methylbenzylamine		l) α -methylbenzylamine		m) α -methylbenzylamine		n) α -methylbenzylamine		o) α -methylbenzylamine		p) α -methylbenzylamine		q) α -methylbenzylamine		r) α -methylbenzylamine		s) α -methylbenzylamine		t) α -methylbenzylamine		u) α -methylbenzylamine		v) α -methylbenzylamine		w) α -methylbenzylamine		x) α -methylbenzylamine		y) α -methylbenzylamine		z) α -methylbenzylamine																																																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

dibutyl tin laurate: 1 g

hydro quinone: 2.5 g

The obtained reaction liquid has a 25.5% by weight solid component, and a 77.3 mPa·s/25 °C viscosity. After applying the obtained polymer solution on a glass plate, it was dried in a reduced pressure at a room temperature over a night for eliminating the solvent. The obtained solid has a 125.5 mg KOH/g acidic value, and a 42,500 weight average molecular weight.

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a. Solid component: 0.7 to 0.8 g of a polymer solution measured accurately was placed in an aluminum plate, and dried at 105 °C for 6 to 7 hours by a hot air drier. The accurate weight was measured immediately for finding the ratio of the measured dried weight with respect to the polymer solution weight.

b. Viscosity (mPa·s/25 °C): With a rotor No. 1 used, the viscosity was measured by a B type viscometer at 60 rpm.

c. Acidic value: The acidic value was found by dissolving a specimen in an acetone, and the neutralization titration by NaOH of 1/10 N with a cresol red used as an indicator.

d. Hydroxyl group value: The hydroxyl group value was found from the KOH weight necessary for neutralizing an acidic value capable of acetylating 1 g of a dried polymer.

e. Weight average molecular weight: GPC measurement condition and column are as follows.

Column: Schodex GPC KF-805L (produced by Showa Denko Corp.)

Flow rate: 1.0 (ml/min)

Temperature: 40 °C

Descriptive statistics	
Age (years)	21.1
Gender	
Male	50.0
Female	50.0
Height (cm)	170.5
Weight (kg)	68.5
Body mass index (kg/m ²)	23.5
Performance	
100 m	16.5
200 m	33.5
400 m	1:05.5
800 m	2:15.5
1600 m	4:35.5
3200 m	9:15.5
6400 m	18:45.5
12800 m	37:45.5
25600 m	75:45.5
51200 m	151:45.5
102400 m	303:45.5
204800 m	607:45.5
409600 m	1215:45.5
819200 m	2431:45.5
1638400 m	4863:45.5
3276800 m	9727:45.5
6553600 m	19455:45.5
13107200 m	38911:45.5
26214400 m	77823:45.5
52428800 m	155647:45.5
104857600 m	311295:45.5
209715200 m	622591:45.5
419430400 m	1245183:45.5
838860800 m	2490367:45.5
1677721600 m	4980735:45.5
3355443200 m	9961471:45.5
6710886400 m	19922943:45.5
13421772800 m	39845887:45.5
26843545600 m	79691775:45.5
53687091200 m	159383551:45.5
107374182400 m	318767103:45.5
214748364800 m	637534207:45.5
429496729600 m	1275068415:45.5
858993459200 m	2550136831:45.5
1717986918400 m	5100273663:45.5
3435973836800 m	10200547327:45.5
6871947673600 m	20401094655:45.5
13743895347200 m	40802189311:45.5
27487790694400 m	81604378623:45.5
54975581388800 m	163208757247:45.5
109951162777600 m	326417514495:45.5
219902325555200 m	652835028991:45.5
439804651110400 m	1305670057983:45.5
879609302220800 m	2611340115967:45.5
1759218604441600 m	5222680231935:45.5
3518437208883200 m	10445360463871:45.5
7036874417766400 m	20890720927743:45.5
14073748835532800 m	41781441855487:45.5
28147497671065600 m	83562883710975:45.5
56294995342131200 m	167125767421951:45.5
112589990684262400 m	334251534843903:45.5
225179981368524800 m	668503069687807:45.5
450359962737049600 m	1337006139375615:45.5
900719925474099200 m	2674012278751231:45.5
1801439850948198400 m	5348024557502463:45.5
3602879701896396800 m	10696049115004927:45.5
7205759403792793600 m	21392098230009855:45.5
14411518807585587200 m	42784196460019711:45.5
28823037615171174400 m	85568392920039423:45.5
57646075230342348800 m	171136785840078847:45.5
115292150460684697600 m	342273571680157695:45.5
230584300921369395200 m	684547143360315391:45.5
461168601842738790400 m	1369094286720630783:45.5
922337203685477580800 m	2738188573441261567:45.5
1844674407370955161600 m	5476377146882523135:45.5
3689348814741910323200 m	10952754293765046271:45.5
7378697629483820646400 m	21905508587530092543:45.5
14757395258967641292800 m	43811017175060185087:45.5
29514790517935282585600 m	87622034350120370175:45.5
59029581035870565171200 m	175244068700240740351:45.5
118059162071741130342400 m	350488137400481480703:45.5
236118324143482260684800 m	700976274800962961407:45.5
472236648286964521369600 m	1401952549601925922815:45.5
944473296573929042739200 m	2803905099203851845631:45.5
1888946593147858085478400 m	5607810198407703691263:45.5
3777893186295716170956800 m	11215620396815407382527:45.5
7555786372591432341913600 m	2243124079363081476505

Descriptive statistics	
Age (years)	21.1
Gender	
Male	50.0
Female	50.0
Height (cm)	170.5
Weight (kg)	68.5
Body mass index (kg/m ²)	23.5
Performance	
100 m	16.5
200 m	33.5
400 m	1:05.5
800 m	2:15.5
1600 m	4:35.5
3200 m	9:15.5
6400 m	18:45.5
12800 m	37:45.5
25600 m	75:45.5
51200 m	151:45.5
102400 m	303:45.5
204800 m	607:45.5
409600 m	1215:45.5
819200 m	2431:45.5
1638400 m	4863:45.5
3276800 m	9727:45.5
6553600 m	19455:45.5
13107200 m	38911:45.5
26214400 m	77823:45.5
52428800 m	155647:45.5
104857600 m	311295:45.5
209715200 m	622591:45.5
419430400 m	1245183:45.5
838860800 m	2490367:45.5
1677721600 m	4980735:45.5
3355443200 m	9961471:45.5
6710886400 m	19922943:45.5
13421772800 m	39845887:45.5
26843545600 m	79691775:45.5
53687091200 m	159383551:45.5
107374182400 m	318767103:45.5
214748364800 m	637534207:45.5
429496729600 m	1275068415:45.5
858993459200 m	2550136831:45.5
1717986918400 m	5100273663:45.5
3435973836800 m	10200547327:45.5
6871947673600 m	20401094655:45.5
13743895347200 m	40802189311:45.5
27487790694400 m	81604378623:45.5
54975581388800 m	163208757247:45.5
109951162777600 m	326417514495:45.5
219902325555200 m	652835028991:45.5
439804651110400 m	1305670057983:45.5
879609302220800 m	2611340115967:45.5
1759218604441600 m	5222680231935:45.5
3518437208883200 m	10445360463871:45.5
7036874417766400 m	20890720927743:45.5
14073748835532800 m	41781441855487:45.5
28147497671065600 m	83562883710975:45.5
56294995342131200 m	167125767421951:45.5
112589990684262400 m	334251534843903:45.5
225179981368524800 m	668503069687807:45.5
450359962737049600 m	1337006139375615:45.5
900719925474099200 m	2674012278751231:45.5
1801439850948198400 m	5348024557502463:45.5
3602879701896396800 m	10696049115004927:45.5
7205759403792793600 m	21392098230009855:45.5
14411518807585587200 m	42784196460019711:45.5
28823037615171174400 m	85568392920039423:45.5
57646075230342348800 m	171136785840078847:45.5
115292150460684697600 m	342273571680157695:45.5
230584300921369395200 m	684547143360315391:45.5
461168601842738790400 m	1369094286720630783:45.5
922337203685477580800 m	2738188573441261567:45.5
1844674407370955161600 m	5476377146882523135:45.5
3689348814741910323200 m	10952754293765046271:45.5
7378697629483820646400 m	21905508587530092543:45.5
14757395258967641292800 m	43811017175060185087:45.5
29514790517935282585600 m	87622034350120370175:45.5
59029581035870565171200 m	175244068700240740351:45.5
118059162071741130342400 m	350488137400481480703:45.5
236118324143482260684800 m	700976274800962961407:45.5
472236648286964521369600 m	1401952549601925922815:45.5
944473296573929042739200 m	2803905099203851845631:45.5
1888946593147858085478400 m	5607810198407703691263:45.5
3777893186295716170956800 m	11215620396815407382527:45.5
7555786372591432341913600 m	2243124079363081476505

Descriptive statistics	
Age (years)	39.1
Gender (male)	50.0
Marital status (married)	50.0
Education (years)	12.5
Income (USD)	12,500
Health status (good)	75.0
Smoking status (smoker)	25.0
Alcohol consumption (drinker)	15.0
Exercise frequency (regular)	30.0
Stress level (high)	40.0
Sleep quality (poor)	35.0
Diet quality (poor)	45.0
Work-life balance (poor)	55.0
Family support (low)	60.0
Community involvement (low)	65.0
Life satisfaction (low)	70.0
Overall health (poor)	75.0
Quality of life (low)	80.0
Life expectancy (low)	85.0
Life expectancy (high)	90.0
Life expectancy (very high)	95.0
Life expectancy (extremely high)	100.0
Life expectancy (very low)	105.0
Life expectancy (extremely low)	110.0
Life expectancy (very poor)	115.0
Life expectancy (poor)	120.0
Life expectancy (fair)	125.0
Life expectancy (good)	130.0
Life expectancy (very good)	135.0
Life expectancy (excellent)	140.0
Life expectancy (outstanding)	145.0
Life expectancy (exceptional)	150.0
Life expectancy (superb)	155.0
Life expectancy (magnificent)	160.0
Life expectancy (marvelous)	165.0
Life expectancy (fantastic)	170.0
Life expectancy (wonderful)	175.0
Life expectancy (amazing)	180.0
Life expectancy (incredible)	185.0
Life expectancy (unbelievable)	190.0
Life expectancy (astounding)	195.0
Life expectancy (stunning)	200.0
Life expectancy (breathtaking)	205.0
Life expectancy (jaw-dropping)	210.0
Life expectancy (mind-blowing)	215.0
Life expectancy (heart-stopping)	220.0
Life expectancy (speech-taking)	225.0
Life expectancy (breath-taking)	230.0
Life expectancy (staggering)	235.0
Life expectancy (astounding)	240.0
Life expectancy (breathtaking)	245.0
Life expectancy (jaw-dropping)	250.0
Life expectancy (mind-blowing)	255.0
Life expectancy (heart-stopping)	260.0
Life expectancy (speech-taking)	265.0
Life expectancy (breath-taking)	270.0
Life expectancy (staggering)	275.0
Life expectancy (astounding)	280.0
Life expectancy (breathtaking)	285.0
Life expectancy (jaw-dropping)	290.0
Life expectancy (mind-blowing)	295.0
Life expectancy (heart-stopping)	300.0
Life expectancy (speech-taking)	305.0
Life expectancy (breath-taking)	310.0
Life expectancy (staggering)	315.0
Life expectancy (astounding)	320.0
Life expectancy (breathtaking)	325.0
Life expectancy (jaw-dropping)	330.0
Life expectancy (mind-blowing)	335.0
Life expectancy (heart-stopping)	340.0
Life expectancy (speech-taking)	345.0
Life expectancy (breath-taking)	350.0
Life expectancy (staggering)	355.0
Life expectancy (astounding)	360.0
Life expectancy (breathtaking)	365.0
Life expectancy (jaw-dropping)	370.0
Life expectancy (mind-blowing)	375.0
Life expectancy (heart-stopping)	380.0
Life expectancy (speech-taking)	385.0
Life expectancy (breath-taking)	390.0
Life expectancy (staggering)	395.0
Life expectancy (astounding)	400.0
Life expectancy (breathtaking)	405.0
Life expectancy (jaw-dropping)	410.0
Life expectancy (mind-blowing)	415.0
Life expectancy (heart-stopping)	420.0
Life expectancy (speech-taking)	425.0
Life expectancy (breath-taking)	430.0
Life expectancy (staggering)	435.0
Life expectancy (astounding)	440.0
Life expectancy (breathtaking)	445.0
Life expectancy (jaw-dropping)	450.0
Life expectancy (mind-blowing)	455.0
Life expectancy (heart-stopping)	460.0
Life expectancy (speech-taking)	465.0
Life expectancy (breath-taking)	470.0
Life expectancy (staggering)	475.0
Life expectancy (astounding)	480.0
Life expectancy (breathtaking)	485.0
Life expectancy (jaw-dropping)	490.0
Life expectancy (mind-blowing)	495.0
Life expectancy (heart-stopping)	500.0
Life expectancy (speech-taking)	505.0
Life expectancy (breath-taking)	510.0
Life expectancy (staggering)	515.0
Life expectancy (astounding)	520.0
Life expectancy (breathtaking)	525.0
Life expectancy (jaw-dropping)	530.0
Life expectancy (mind-blowing)	535.0
Life expectancy (heart-stopping)	540.0
Life expectancy (speech-taking)	545.0
Life expectancy (breath-taking)	550.0
Life expectancy (staggering)	555.0
Life expectancy (astounding)	560.0
Life expectancy (breathtaking)	565.0
Life expectancy (jaw-dropping)	570.0
Life expectancy (mind-blowing)	575.0
Life expectancy (heart-stopping)	580.0
Life expectancy (speech-taking)	585.0
Life expectancy (breath-taking)	590.0
Life expectancy (staggering)	595.0
Life expectancy (astounding)	600.0
Life expectancy (breathtaking)	605.0
Life expectancy (jaw-dropping)	610.0
Life expectancy (mind-blowing)	615.0
Life expectancy (heart-stopping)	620.0
Life expectancy (speech-taking)	625.0
Life expectancy (breath-taking)	630.0
Life expectancy (staggering)	635.0
Life expectancy (astounding)	640.0
Life expectancy (breathtaking)	645.0
Life expectancy (jaw-dropping)	650.0
Life expectancy (mind-blowing)	655.0
Life expectancy (heart-stopping)	660.0
Life expectancy (speech-taking)	665.0
Life expectancy (breath-taking)	670.0
Life expectancy (staggering)	675.0
Life expectancy (astounding)	680.0

Descriptive statistics	
Age (years)	21.1
Gender	
Male	50.0
Female	50.0
Height (cm)	170.5
Weight (kg)	68.5
Body mass index (kg/m ²)	23.5
Performance	
100 m	16.5
200 m	33.5
400 m	1:05.5
800 m	2:15.5
1600 m	4:35.5
3200 m	9:15.5
6400 m	18:45.5
12800 m	37:45.5
25600 m	75:45.5
51200 m	151:45.5
102400 m	303:45.5
204800 m	607:45.5
409600 m	1215:45.5
819200 m	2431:45.5
1638400 m	4863:45.5
3276800 m	9727:45.5
6553600 m	19455:45.5
13107200 m	38911:45.5
26214400 m	77823:45.5
52428800 m	155647:45.5
104857600 m	311295:45.5
209715200 m	622591:45.5
419430400 m	1245183:45.5
838860800 m	2490367:45.5
1677721600 m	4980735:45.5
3355443200 m	9961471:45.5
6710886400 m	19922943:45.5
13421772800 m	39845887:45.5
26843545600 m	79691774:45.5
53687091200 m	159383549:45.5
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879609302220800 m	2611340068992:45.5
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3518437208883200 m	10445360275968:45.5
7036874417766400 m	20890720551936:45.5
14073748835532800 m	41781441103872:45.5
28147497671065600 m	83562882207744:45.5
56294995342131200 m	167125764415488:45.5
112589990684262400 m	334251528830976:45.5
225179981368524800 m	668503057661952:45.5
450359962737049600 m	1337006115323904:45.5
900719925474099200 m	2674012230647808:45.5
1801439850948198400 m	5348024461295616:45.5
3602879701896396800 m	10696048922591232:45.5
7205759403792793600 m	21392097845182464:45.5
14411518807585587200 m	42784195690364928:45.5
28823037615171174400 m	85568391380729856:45.5
57646075230342348800 m	171136782761459712:45.5
115292150460684697600 m	342273565522919424:45.5
230584300921369395200 m	684547131045838848:45.5
461168601842738790400 m	1369094262091677696:45.5
922337203685477580800 m	2738188524183355392:45.5
1844674407370955161600 m	5476377048366710784:45.5
3689348814741910323200 m	10952754096733421568:45.5
7378697629483820646400 m	21905508193466843136:45.5
14757395258967641292800 m	43811016386933686272:45.5
29514790517935282585600 m	87622032773867372544:45.5
59029581035870565171200 m	175244065547734745088:45.5
118059162071741130342400 m	350488131095469490176:45.5
236118324143482260684800 m	700976262190938980352:45.5
472236648286964521369600 m	1401952524381877960704:45.5
944473296573929042739200 m	2803905048763755921408:45.5
1888946593147858085478400 m	5607810097527511842816:45.5
3777893186295716170956800 m	11215620195055023685632:45.5
7555786372591432341913600 m	2243124039011004737126

[illegible]

Descriptive statistics	
Age (years)	39.1
Gender (male)	50.0
Marital status (married)	50.0
Education (years)	12.5
Income (USD)	12,500
Health status (good)	75.0
Smoking status (smoker)	25.0
Alcohol consumption (drinker)	15.0
Exercise frequency (regular)	30.0
Stress level (high)	40.0
Sleep quality (poor)	35.0
Diet quality (poor)	45.0
Work-life balance (poor)	55.0
Family support (low)	60.0
Community involvement (low)	65.0
Life satisfaction (low)	70.0
Overall health (poor)	75.0
Quality of life (poor)	80.0
Life expectancy (years)	85.0
Life expectancy (months)	100.0
Life expectancy (weeks)	120.0
Life expectancy (days)	140.0
Life expectancy (hours)	160.0
Life expectancy (minutes)	180.0
Life expectancy (seconds)	200.0
Life expectancy (milliseconds)	220.0
Life expectancy (microseconds)	240.0
Life expectancy (nanoseconds)	260.0
Life expectancy (picoseconds)	280.0
Life expectancy (femtoseconds)	300.0
Life expectancy (attoseconds)	320.0
Life expectancy (zeptoseconds)	340.0
Life expectancy (yoctoseconds)	360.0
Life expectancy (rattoseconds)	380.0
Life expectancy (quectoseconds)	400.0
Life expectancy (sextoseconds)	420.0
Life expectancy (septoseconds)	440.0
Life expectancy (octoseconds)	460.0
Life expectancy (nonoseconds)	480.0
Life expectancy (decoseconds)	500.0
Life expectancy (centiseconds)	520.0
Life expectancy (milliseconds)	540.0
Life expectancy (microseconds)	560.0
Life expectancy (nanoseconds)	580.0
Life expectancy (picoseconds)	600.0
Life expectancy (femtoseconds)	620.0
Life expectancy (attoseconds)	640.0
Life expectancy (zeptoseconds)	660.0
Life expectancy (yoctoseconds)	680.0
Life expectancy (rattoseconds)	700.0
Life expectancy (quectoseconds)	720.0
Life expectancy (sextoseconds)	740.0
Life expectancy (septoseconds)	760.0
Life expectancy (octoseconds)	780.0
Life expectancy (nonoseconds)	800.0
Life expectancy (decoseconds)	820.0
Life expectancy (centiseconds)	840.0
Life expectancy (milliseconds)	860.0
Life expectancy (microseconds)	880.0
Life expectancy (nanoseconds)	900.0
Life expectancy (picoseconds)	920.0
Life expectancy (femtoseconds)	940.0
Life expectancy (attoseconds)	960.0
Life expectancy (zeptoseconds)	980.0
Life expectancy (yoctoseconds)	1000.0

Diethylene glycol dimethyl ether: 59.0 parts by weight

3-methoxy butyl acetate: 7.4 parts by weight

[Example 3]

<Formation of a black matrix>

The components by the below-mentioned amounts were mixed, and dispersed by means of a sand mill for preparing a black pigment dispersion liquid.

Black pigment: 23 parts by weight

Polymer dispersing agent (produced by Bic Chemie Japan, Corp., Disperbyk 111): 2 parts by weight

Solvent (diethylene glycol dimethyl ether): 75 parts by weight

Then, the components by the below-mentioned amounts were mixed and dispersed sufficiently so as to obtain a light blocking layer composition.

The above-mentioned black pigment dispersion liquid: 61 parts by weight

The above-mentioned photo-curing resin composition (1): 20 parts by weight

Diethylene glycol dimethyl ether: 30 parts by weight

The above-mentioned light blocking layer composition was applied on the glass substrate having a 1.1 mm thickness (produced by Asahi Glass Corp., Al material) with a spin coater, and dried at 100 °C for 3 minutes so as to form a light blocking layer of about 1 μ m film thickness. The light blocking layer was exposed by an extra-high pressure mercury lamp in a light blocking pattern, and developed by an 0.05% aqueous solution of potassium hydroxide. Then, by leaving the substrate in an atmosphere at 180 °C for 30 minutes, a heat treatment was applied so as to form the black matrix in the area for forming a light blocking part.

<Formation of a coloring layer>

A red photo-curing resin composition with the below-mentioned composition was applied onto the substrate produced as mentioned above by the spin coating method (application thickness 1.5 μ m), and was dried in an oven at 70 °C for 30 minutes.

With a photo mask disposed at a 100 μ m distance from the coated film of the red photo-curing resin composition, an ultraviolet ray was directed only to the area corresponding to the coloring layer formation area for 10 seconds using a 2.0 kW extra-high pressure mercury lamp by a proximity aligner. Then, it was soaked in a 0.05% aqueous solution of potassium hydroxide (liquid temperature: 23 °C) for 1 minute for alkaline development so as to eliminate only the unhardened part of the

polysulfonic acid type polymer dispersing agent: 3
parts by weight

the above-mentioned photo-curing resin composition
(1): 5 parts by weight

3-methoxy butyl acetate: 82 parts by weight

c. Blue photo-curing resin composition:

C. I. Pigment blue: 10 parts by weight

polysulfonic acid type polymer dispersing agent: 3
parts by weight

the above-mentioned photo-curing resin composition
(1): 5 parts by weight

3-methoxy butyl acetate: 82 parts by weight

[Example 4]

<Application of the photo-curing resin composition (1)>

The photo-curing resin composition (1) with the
above-mentioned composition was applied on a glass substrate
with a coloring layer formed in the Example 3 by the spin coating
method, and dried so as to form a coated film with a 2 μ m dry
film thickness.

<Exposure and development>

With a photo mask disposed at a 100 μ m distance from
the coated film of the photo-curing resin composition (1), an
ultraviolet ray was directed only to the area corresponding to

the coloring layer formation area for 10 seconds using a 2.0 kW extra-high pressure mercury lamp by a proximity aligner. Then, it was soaked in a 0.05% aqueous solution of potassium hydroxide (liquid temperature: 23 °C) for 1 minute for alkaline development so as to eliminate only the unhardened part of the photo-curing resin composition coated film. A protection film was formed by applying a heat treatment by leaving the substrate in an atmosphere at 200 °C for 30 minutes, thereby obtaining a color filter according to the present invention.

[Example 5]

<Preparation of photo-curing resin compositions (2) and (2')>

A photo-curing resin composition (2) was obtained by agitating and mixing the materials of the below-mentioned amounts at a room temperature.

Moreover, with the reaction liquid obtained in the Example 1 not applied with the alcohol treatment used instead of the reaction product applied with the alcohol treatment in the below-mentioned composition, a photo-curing resin composition (2') was obtained.

Reaction product applied with the alcohol treatment obtained in the Example 1 (23.2% by weight solid component):
970 parts by weight

Dipentaerythritol pentaacrylate (produced by

Thertomer Corp., SR399): 18.0 parts by weight

Orthocresol novolak type epoxy resin (produced by Yuka Shell Epoxy Corp., Epi Coat 180S70): 25.0 parts by weight

2-benzyl-2-N,N-dimethyl amino-1-(4-morfolyno phenyl)-1-butanone: 2.5 parts by weight

2,2'-bis(o-chrolo phenyl)-4,5,4',5'-tetra phenyl-1,2'-biimidazol: 2.0 parts by weight

Polyoxy ethylene octyl phenyl ether (Nonion HS-210, produced by Nippon Yushi Corp.): 3.6 parts by weight

Propylene glycol monomethyl ether acetate: 59.0 parts by weight

<Storage test>

The viscosity of the above-mentioned photo-curing resin compositions (2) and (2') was measured by a B type viscometer immediately after the preparation. It was 20.0 mPa·s/25 °C for the photo-curing resin composition (2'), and it was 18.5 mPa·s/25 °C for the photo-curing resin composition (2) applied with the alcohol treatment. Furthermore, the viscosity was measured after refrigeration, storage in a room temperature, and at a high temperature of the photo-curing resin compositions (2) and (2'). Results are shown in the below-mentioned table.

TABLE 2

	Photo-curing resin composition (2) (alcohol treatment)	Photo-curing resin composition (2') (untreated)
Refrigeration storage (2 weeks)	1.032 times	1.049 times
Room temperature storage (2 weeks)	1.064 times	1.208 times

<Application of the photo-curing resin composition (2)>

The photo-curing resin composition (2) with the above-mentioned composition was applied on a glass substrate with a coloring layer formed in the Example 3 by the spin coating method, and dried so as to form a coated film with a 5 μm dry film thickness.

<Exposure and development>

With a photo mask designed for forming an exposure pattern with predetermined shape, size, and interval, disposed at a 100 μm distance from the coated film of the photo-curing resin composition (2), an ultraviolet ray was directed only to the spacer formation area on the black matrix for 10 seconds using a 2.0 kW extra-high pressure mercury lamp by a proximity aligner. Then, it was soaked in a 0.05% aqueous solution of potassium hydroxide (liquid temperature: 23 $^{\circ}\text{C}$) for 1 minute for alkaline development so as to eliminate only the unhardened part of the photo-curing resin composition coated film. A fixing spacer was formed by applying a heat treatment by leaving

Table 1. Demographic characteristics of the study population	
Age (years)	65.0 ± 10.0
Gender (male/female)	100/100
Education (years)	12.0 ± 2.0
Marital status (married/divorced/widowed)	80/20/0
Occupation (retired/working)	90/10
Income (USD/month)	1500 ± 500
Comorbidities (hypertension/diabetes/cholesterol)	70/30/40
Medication (antidepressants/antipsychotics)	50/10
Alcohol consumption (yes/no)	20/80
Smoking status (current/former/never)	10/40/50
Family history (depression/schizophrenia)	30/10
Stress levels (high/low)	40/60
Social support (strong/weak)	30/70
Life events (recent/none)	20/80
Physical health (good/poor)	60/40
Substance use (drugs/alcohol)	10/10
Legal issues (yes/no)	10/90
Religious beliefs (strong/weak)	40/60
Community involvement (yes/no)	30/70
Healthcare access (easy/difficult)	50/50
Transportation (own car/public)	40/60
Food security (yes/no)	60/40
Housing stability (yes/no)	70/30
Employment status (unemployed/employed)	10/90
Financial stress (high/low)	40/60
Relationship satisfaction (yes/no)	30/70
Parenting stress (yes/no)	20/80
Child health (good/poor)	60/40
Child education (yes/no)	70/30
Child behavior (stable/unstable)	50/50
Child social skills (good/poor)	40/60
Child academic performance (yes/no)	30/70
Child emotional well-being (yes/no)	20/80
Child physical health (yes/no)	60/40
Child safety (yes/no)	70/30
Child supervision (yes/no)	80/20
Child discipline (consistent/inconsistent)	60/40
Child communication (yes/no)	50/50
Child social interaction (yes/no)	40/60
Child academic achievement (yes/no)	30/70
Child emotional stability (yes/no)	20/80
Child physical activity (yes/no)	60/40
Child sleep patterns (yes/no)	70/30
Child eating habits (yes/no)	80/20
Child hygiene (yes/no)	90/10
Child safety measures (yes/no)	100/0
Child supervision levels (yes/no)	100/0
Child discipline methods (yes/no)	100/0
Child communication skills (yes/no)	100/0
Child social skills training (yes/no)	100/0
Child academic support (yes/no)	100/0
Child emotional support (yes/no)	100/0
Child physical health monitoring (yes/no)	100/0
Child safety protocols (yes/no)	100/0
Child supervision strategies (yes/no)	100/0
Child discipline techniques (yes/no)	100/0
Child communication exercises (yes/no)	100/0
Child social skills development (yes/no)	100/0
Child academic performance tracking (yes/no)	100/0
Child emotional well-being assessment (yes/no)	100/0
Child physical health check-ups (yes/no)	100/0
Child safety drills (yes/no)	100/0
Child supervision schedules (yes/no)	100/0
Child discipline plans (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0
Child safety goals (yes/no)	100/0
Child supervision goals (yes/no)	100/0
Child discipline goals (yes/no)	100/0
Child communication goals (yes/no)	100/0
Child social skills goals (yes/no)	100/0
Child academic goals (yes/no)	100/0
Child emotional goals (yes/no)	100/0
Child physical health goals (yes/no)	100/0

A transparent electrode film was formed on the surface including the fixing spacer of the color filter obtained in the example 5 by a DC magnetron sputtering method with argon and oxygen used as the discharging gas at a 200 °C substrate temperature, and ITO as the target. Then, an alignment layer comprising polyimide was further formed on the transparent electrode film.

[Example 7]

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Table 1. Demographic characteristics of the study population	
Characteristic	Value
Age (years)	65.2 ± 1.5
Gender (male/female)	102/108
Education (years)	12.5 ± 0.5
Marital status (married/divorced/widowed)	150/30/20
Occupation (retired/working)	150/30
Income (€ per month)	1,200 ± 100
Comorbidities (hypertension/diabetes/cholesterol)	120/40/60
Medication (antidepressants/antipsychotics)	80/20
Alcohol consumption (yes/no)	30/170
Smoking status (current/former/never)	20/80/160
Family history of mental illness (yes/no)	30/170
Duration of illness (years)	10.5 ± 2.0
Previous hospitalizations (yes/no)	50/120
Current symptoms (depression/anxiety)	100/100
Functional status (independent/dependent)	150/30
Social support (strong/weak)	100/70
Quality of life (score)	65.0 ± 5.0
Overall health (good/poor)	120/80
Life satisfaction (high/low)	100/70
Stress levels (low/high)	100/70
Resilience (high/low)	100/70
Perceived burden (low/high)	100/70
Healthcare utilization (frequent/infrequent)	50/120
Adherence to treatment (yes/no)	100/70
Health insurance (public/private)	150/30
Geographical location (urban/rural)	100/70
Season of study (spring/summer/autumn/winter)	40/40/40/40
Study duration (months)	12
Sample size (n)	210

Table 1. Demographic characteristics of the study population	
Characteristic	Value
Age (years)	65.2 ± 1.5
Gender (male/female)	102/108
Education (years)	12.5 ± 0.5
Marital status (married/divorced/widowed)	115/45/43
Occupation (retired/working)	117/93
Income (€ per month)	1,200 ± 150
Comorbidities (hypertension/diabetes/cholesterol)	115/85/75
Medication (antidepressants/antipsychotics)	115/45
Alcohol consumption (g/day)	20 ± 10
Smoking status (smoker/nonsmoker)	115/93
Family size (number of children)	2.5 ± 0.5
Living arrangement (alone/together)	115/93
Health status (good/poor)	115/45
Life satisfaction (score 1-10)	6.5 ± 1.0
Stress level (low/high)	115/45
Depression score (0-100)	45 ± 15
Overall health score (0-100)	75 ± 10

Table 1. Demographic characteristics of the study population	
Characteristic	Value
Age (mean \pm SD)	65.2 \pm 12.5
Gender (male/female)	112/108
Education (years)	12.5 \pm 2.1
Marital status (married/divorced/widowed)	150/45/10
Occupation (retired/employed)	180/30
Income (monthly, \$)	1,200 \pm 300
Health status (good/fair/poor)	150/45/10
Smoking status (smoker/nonsmoker)	40/180
Alcohol consumption (yes/no)	20/190
Comorbidities (hypertension/diabetes/cholesterol)	120/80/100
Medication (antidepressant/antipsychotic)	10/190
Family history (depression/schizophrenia)	30/160
Stressors (work/family/health)	150/45/10
Support system (strong/weak)	120/70
Quality of life (high/low)	150/45
Overall sample size	300

Table 1. Demographic characteristics of the study population	
Characteristic	Value
Age (years)	65.2 ± 1.5
Gender (male/female)	102/108
Education (years)	12.5 ± 0.5
Marital status (married/divorced/widowed)	150/30/20
Occupation (retired/working)	150/30
Income (€ per month)	1,200 ± 200
Comorbidities (hypertension/diabetes/cholesterol)	120/40/60
Medication (antidepressants/antipsychotics)	80/20
Alcohol consumption (yes/no)	30/170
Smoking status (smoker/non-smoker)	20/180
Family history of mental illness (yes/no)	10/190
Previous psychiatric hospitalization (yes/no)	10/180
Current psychiatric treatment (yes/no)	10/180
Duration of illness (years)	10.5 ± 2.5
Onset of illness (age)	55.0 ± 2.0
Duration of current episode (months)	6.0 ± 1.0
Number of previous episodes	2.0 ± 0.5
Severity of current episode (mild/moderate/severe)	10/40/10
Response to treatment (yes/no)	10/10
Relapse rate (yes/no)	10/10
Quality of life (score)	75.0 ± 5.0
Social support (yes/no)	10/10
Stress levels (high/low)	10/10
Life satisfaction (yes/no)	10/10
Overall health (good/fair/poor)	10/40/10
Physical health (yes/no)	10/10
Mental health (yes/no)	10/10
Functional status (yes/no)	10/10
Work status (yes/no)	10/10
Family relationships (yes/no)	10/10
Community involvement (yes/no)	10/10
Self-esteem (yes/no)	10/10
Hope (yes/no)	10/10
Meaning in life (yes/no)	10/10
Life goals (yes/no)	10/10
Future outlook (yes/no)	10/10
Overall well-being (yes/no)	10/10

[illegible][illegible]

Polymerization inhibitor: 2.5 g of 3,5 di-tert-butyl-4-hydroxy toluene (BHT)

<sample 8b>

Polymerization initiator (non-nitrile-based): 5g of dimethyl 2,2'-azo bis(2-methyl propionate)

Polymerization inhibitor: 2.5 g of hydro quinone

<sample 8c>

Polymerization initiator (non-nitrile-based): 5g of dimethyl 2,2'-azo bis(2-methyl propionate)

Polymerization inhibitor: 2.5 g of metho quinone

<sample 8d>

Polymerization initiator (nitrile-based): 5g of azo bis isobutyl nitrile

Polymerization inhibitor: 2.5 g of 3,5 di-tert-butyl-4-hydroxy toluene (BHT)

<sample 8e>

Polymerization initiator (nitrile-based): 5g of azo bis isobutyl nitrile

Polymerization inhibitor: 2.5 g of hydro quinone

<sample 8f>

Polymerization initiator (nitrile-based): 5g of azo bis isobutyl nitrile

Polymerization inhibitor: 2.5 g of metho quinone

<Measurement of the light transmittance>

The reaction liquids as the photo-curing polymer

samples (8a to 8f) were diluted with 3-methoxy butyl acetate so as to prepare a solution with a 20% by weight resin component, and placed in a 1 cm square quartz cell for measuring the light transmittance in the range from 350 nm to 550 nm.

The measurement results are shown in Table 3, FIG. 3, and FIG. 4. Table 3 shows the light transmittance of each sample at 360 nm (ultraviolet), 400 nm (visible), and 485 nm (visible). FIG. 3 shows the transmittance curve of the samples with the same non-nitrile-based polymerization initiator and different polymerization inhibitors. Moreover, FIG. 4 shows the transmittance curve of the samples with the same nitrile-based polymerization initiators and different polymerization inhibitor. However, FIG. 4 also shows the transmittance curve of the sample 8a using the non-nitrile-based polymerization initiator.

TABLE 3

	360nm	400nm	485nm
Sample 8a	70 (%)	87 (%)	94 (%)
Sample 8b	12	38	78
Sample 8c	19	47	72
Sample 8d	14	52	42
Sample 8e	17	53	75
Sample 8f	4	26	28

Although drop of the transmittance is observed in the vicinity of 485 nm in the sample group using the nitrile-based polymerization initiator shown in FIG. 4, the drop of the

compared with the product not applied with the alcohol treatment. Therefore, the excellent storage property of a prepared solution can be provided so that a long term storage in a room temperature can be enabled. Moreover, since a solution of the alcohol treated product does not have a viscosity rise during use, and thus it can be handled easily.

Particularly by mixing the photo-curing polymer represented by the above-mentioned formula (8) with another resist material after sufficient maturation, a photo resist material suitable for forming a protection film for covering a coloring layer of a color filter or a column-like spacer for maintaining the cell gap of a liquid crystal panel can be obtained. The resist material can be stored over a long term at a room temperature. Besides, since the viscosity is not changed even during the application by a spin coater, a protection layer with a desired film thickness or a column-like spacer with a desired height can be formed accurately. Therefore, the color irregularity and the contrast irregularity of the liquid crystal display device can be reduced as well.

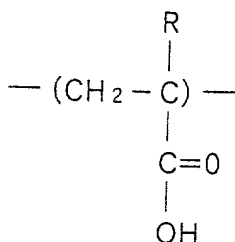
Moreover, by preparing a material polymer using a non-nitrile-based azo polymerization initiator at the time of producing a highly stable resin according to the present invention and/or by introducing an isocyanate compound using a polymerization inhibitor selected from the compounds represented by the above-mentioned formulae (10) and (16), a

highly stable resin with the excellent transparency can be obtained. Therefore, demand for the transparency necessary for a coloring layer of a color filter and a protection film can be satisfied.

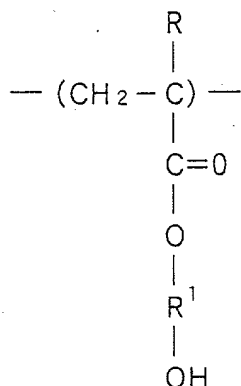
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Variable	Mean	SD	Min	Max
Age	34.5	10.2	21	55
Gender	0.5	0.5	0	1
Marital status	0.6	0.5	0	1
Education	12.5	1.5	9	16
Income	15.2	5.8	5	35
Health status	0.8	0.4	0	1
Smoking status	0.3	0.5	0	1
Alcohol consumption	0.2	0.4	0	1
Exercise frequency	0.5	0.5	0	1
Stress level	3.2	1.8	1	5
Sleep quality	0.7	0.5	0	1
Work satisfaction	0.6	0.5	0	1
Life satisfaction	0.8	0.4	0	1

- Formula (1)



Formula (2)



wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, and R¹ is an alkylene group having 2 to 4 carbon atoms.

3. The highly stable resin according to claim 1, wherein the isocyanate compound has a reactive group other than the isocyanate group.

4. The highly stable resin according to claim 3, wherein the isocyanate compound is a radical polymerizable group-containing isocyanate compound.

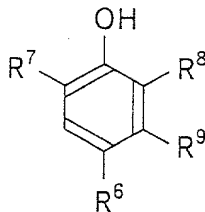
5. The highly stable resin according to claim 1, wherein the principal chain part of the highly stable resin is formed by polymerization of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator.

6. The highly stable resin according to claim 5, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm is 60% or more.

7. The highly stable resin according to claim 5, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm is 50% or more.

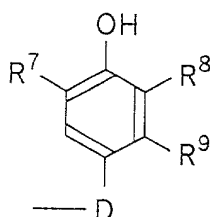
8. The highly stable resin according to claim 1, wherein the isocyanate compound is introduced in the principal chain part of the highly stable resin, using a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16):

Formula (10)



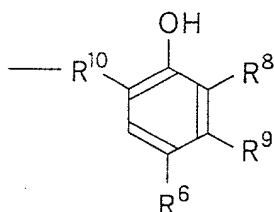
wherein R⁶ is hydrogen, an alkyl group having 1 to 5 carbon atoms, or the below-mentioned formula (11):

Formula (11)



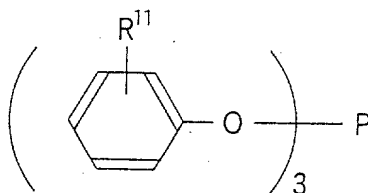
wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁷ is hydrogen or an alkyl group having 1 to 10 carbon atoms. R⁸ is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

Formula (12)



wherein R¹⁰ in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁹ is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R⁷ and R⁸ is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R¹¹ is hydrogen or an alkyl group having 1 to 20 carbon atoms.

9. The highly stable resin according to claim 8, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm is 60% or more.

10. The highly stable resin according to claim 8, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm is 50% or more.

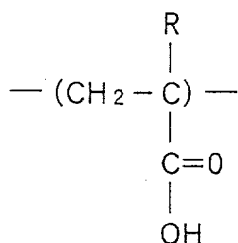
11. A highly stable resin comprising a polymer obtained by reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, and further reacting the same with an alcohol.

12. The highly stable resin according to claim 11, wherein the material polymer is reacted with the isocyanate compound so as to be bonded with at least a part of the acidic functional

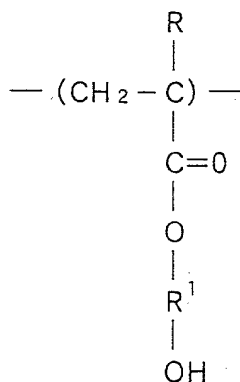
group and/or the hydroxyl group via the isocyanate group of the isocyanate compound, and the acid anhydride part produced as a side product of the dehydration condensation of the acid functional groups by the function of the isocyanate compound is addition-reacted with the alcohol so as to provide the ester bond via the hydroxyl group of the alcohol.

13. The highly stable resin according to claim 11, wherein the principal chain comprises at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2):

Formula (1)



Formula (2)



wherein R is hydrogen or an alkyl group having 1 to 5

carbon atoms, and R¹ is an alkylene group having 2 to 4 carbon atoms.

14. The highly stable resin according to claim 11, wherein the isocyanate compound has a reactive group other than the isocyanate group.

15. The highly stable resin according to claim 14, wherein the isocyanate group is a radical polymerizable group-containing isocyanate compound.

16. The highly stable resin according to claim 11, wherein the principal chain part of the highly stable resin is formed by polymerization of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator.

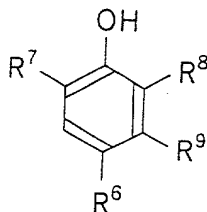
17. The highly stable resin according to claim 16, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm is 60% or more.

18. The highly stable resin according to claim 16, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square

quartz cell at 360 nm is 50% or more.

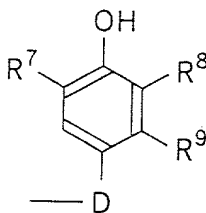
19. The highly stable resin according to claim 11, wherein the isocyanate compound is introduced in the principal chain part of the highly stable resin, using a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16):

Formula (10)



wherein R⁶ is hydrogen, an alkyl group having 1 to 5 carbon atoms, or the below-mentioned formula (11):

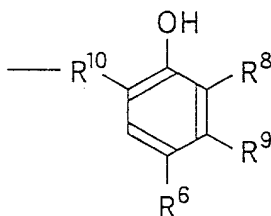
Formula (11)



wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁷ is hydrogen or an alkyl group having 1 to 10 carbon atoms. R⁸ is hydrogen, an alkyl group having 1 to

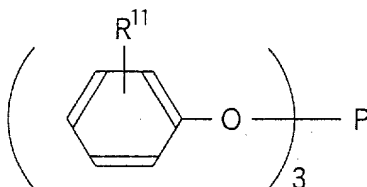
10 carbon atoms, or the below-mentioned formula (12):

Formula (12)



wherein R^{10} in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R^9 is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R^7 and R^8 is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R^{11} is hydrogen or an alkyl group having 1 to 20 carbon atoms.

20. The highly stable resin according to claim 19, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm is 60% or more.

21. The highly stable resin according to claim 19, wherein the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm is 50% or more.

22. A production method for a highly stable resin comprising the steps of reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound, and further reacting the same with an alcohol.

23. The production method for a highly stable resin according to claim 22, wherein the alcohol is added to the solution of the polymer obtained by reacting the material polymer and the isocyanate compound dissolved or dispersed in a solvent before viscosity rise of the solution or before completion of viscosity rise of the solution.

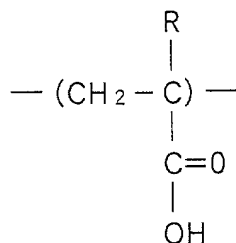
24. The production method for a highly stable resin according to claim 23, wherein the polymer applied with the alcohol treatment are left or heated for a predetermined time for maturation after the addition of the alcohol.

25. The production method for a highly stable resin according to claim 24, wherein the polymer is matured at 30 to 170 °C for

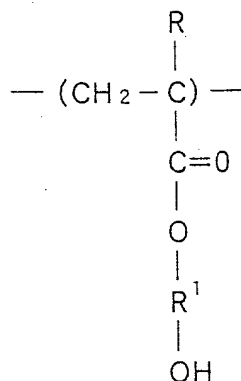
a period within 72 hours.

26. The production method for a highly stable resin according to claim 22, wherein the principal chain of the material polymer comprises at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2):

Formula (1)



Formula (2)



wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, and R¹ is an alkylene group having 2 to 4 carbon atoms.

27. The production method for a highly stable resin according

to claim 22, wherein the isocyanate compound has a reactive group other than the isocyanate group.

28. The production method for a highly stable resin according to claim 27, wherein the isocyanate group is a radical polymerizable group-containing isocyanate compound.

29. The production method for a highly stable resin according to claim 22, wherein a compound having a double bond-containing group and an acidic functional group is reacted with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator so as to prepare the material polymer, and the material polymer is reacted with the isocyanate compound.

30. The production method for a highly stable resin according to claim 29, wherein a highly stable resin with the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm being 60% or more is obtained.

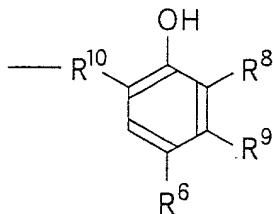
31. The production method for a highly stable resin according to claim 29, wherein a highly stable resin with the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm being 50% or more is obtained.

[illegible]

A benzene ring with a hydroxyl group (OH) at the top position. Substituents R⁷, R⁸, and R⁹ are at the ortho, meta, and para positions respectively, starting from the OH group. Substituent R⁶ is at the bottom position, which is the other ortho position relative to the OH group.

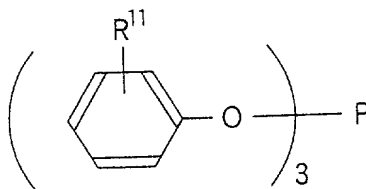
101

Formula (12)



wherein R^{10} in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R^9 is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R^7 and R^8 is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R^{11} is hydrogen or an alkyl group having 1 to 20 carbon atoms.

33. The production method for a highly stable resin according to claim 32, wherein a highly stable resin with the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm being 60% or more is obtained.

34. The production method for a highly stable resin according to claim 32, wherein a highly stable resin with the light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm being 50% or more is obtained.

35. A hardenable resin composition containing as the essential component a hardenable polymer obtained by reacting material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound having a hardenable reactive group, and further reacting the same with an alcohol.

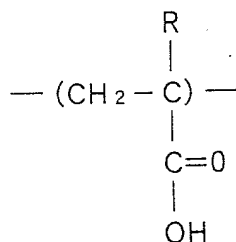
36. The hardenable resin composition according to claim 35, wherein the hardenable polymer is obtained by reacting the material polymer with the isocyanate compound and the alcohol, and further being left or heated for a predetermined time for maturation.

37. The hardenable resin composition according to claim 35, containing as the essential component the hardenable polymer dissolved or dispersed in a coating solvent, wherein the hardenable polymer is obtained by reacting the material polymer with the isocyanate compound, and further reacting the same with an alcohol having a boiling point with a 75 °C or less difference

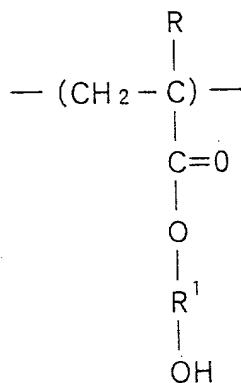
with respect to the boiling point of the coating solvent to be used and/or an evaporation rate with a 90[n-BuOAc=100] or less difference with respect to the evaporation rate of the coating solvent.

38. The hardenable resin composition according to claim 35, wherein the principal chain of the material polymer comprises at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2):

Formula (1)



Formula (2)



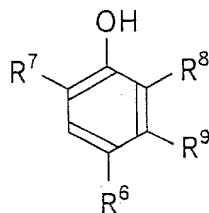
wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, and R¹ is an alkylene group having 2 to 4 carbon

atoms, and

the isocyanate compound is a radical polymerizable group-containing isocyanate compound.

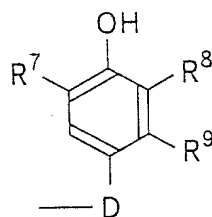
39. The hardenable resin composition according to claim 35, wherein the material polymer is formed by polymerization of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator, and the material polymer is reacted with the isocyanate compound, using a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16):

Formula (10)



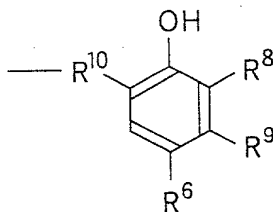
wherein R^6 is hydrogen, an alkyl group having 1 to 5 carbon atoms, or the below-mentioned formula (11):

Formula (11)



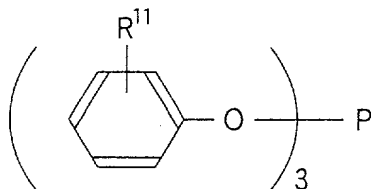
wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁷ is hydrogen or an alkyl group having 1 to 10 carbon atoms. R⁸ is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

Formula (12)



wherein R¹⁰ in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁹ is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R⁷ and R⁸ is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R^{11} is hydrogen or an alkyl group having 1 to 20 carbon atoms.

40. The hardenable resin composition according to claim 39, wherein the hardenable resin polymer has a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm being 60% or more.

41. The hardenable resin composition according to claim 39, wherein the hardenable resin polymer has a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm being 50% or more.

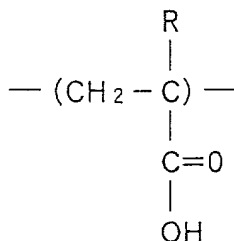
42. A production method for a hardenable resin composition comprising the steps of preparing a polymer by reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound having a hardenable reactive group, preparing a solution by dissolving or dispersing the prepared polymer in

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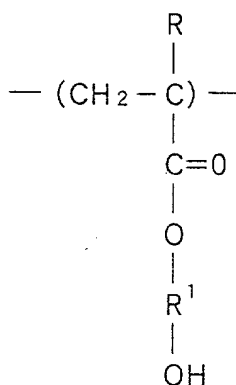
a solvent, adding an alcohol to the solution before viscosity rise of the solution or before completion of viscosity rise of the solution for reaction, preparing a hardenable polymer by leaving or heating the polymer applied with the alcohol treatment for a predetermined time for maturation, and mixing the obtained hardenable polymer with other components.

43. The production method for a hardenable resin composition according to claim 42, wherein the principal chain of the material polymer comprises at least a component unit represented by the below-mentioned formula (1) and a component unit represented by the below-mentioned formula (2):

Formula (1)



Formula (2)



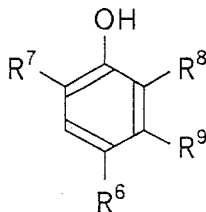
wherein R is hydrogen or an alkyl group having 1 to 5 carbon atoms, and R¹ is an alkylene group having 2 to 4 carbon atoms,

the isocyanate compound is a radical polymerizable group-containing isocyanate compound, and

the polymer is matured at 30 to 170 °C for a period within 72 hours.

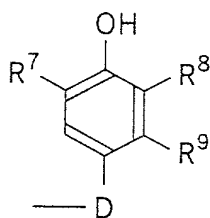
44. The production method for a hardenable resin composition according to claim 42, wherein the material polymer is prepared by polymerization of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator, and the material polymer is reacted with the isocyanate compound, using a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16):

Formula (10)



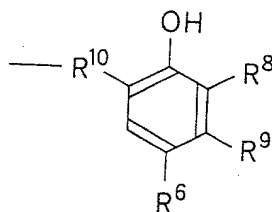
wherein R⁶ is hydrogen, an alkyl group having 1 to 5 carbon atoms, or the below-mentioned formula (11):

Formula (11)



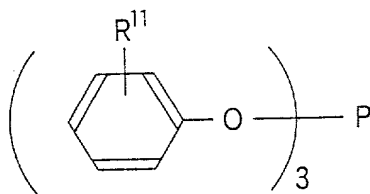
wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁷ is hydrogen or an alkyl group having 1 to 10 carbon atoms. R⁸ is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

Formula (12)



wherein R¹⁰ in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R⁹ is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R⁷ and R⁸ is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R¹¹ is hydrogen or an alkyl group having 1 to 20 carbon atoms.

45. The production method for a hardenable resin composition according to claim 44, wherein a polymer having a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm being 60% or more is prepared by reacting the material polymer with an isocyanate compound, and applying the alcohol treatment to the polymer.

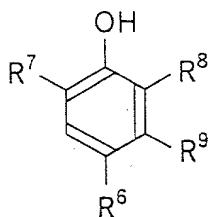
46. The production method for a hardenable resin composition according to claim 44, wherein a polymer having a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm being 50% or more is prepared by reacting the material polymer with an isocyanate compound, and applying the alcohol treatment to the polymer.

47. A production method for a hardenable resin composition containing as the essential component a hardenable polymer dissolved or dispersed in a coating solvent, comprising the

steps of preparing a polymer by reacting a material polymer having a principal chain including at least a component unit having an acidic functional group and a component unit having a hydroxyl group with an isocyanate compound having a hardenable reactive group, preparing a solution by dissolving or dispersing the prepared polymer in a solvent, adding an alcohol having a boiling point with a 75 °C or less difference with respect to the boiling point of the coating solvent to be used and/or an evaporation rate with a 90[n-BuOAc=100] or less difference with respect to the evaporation rate of the coating solvent in the solution before viscosity rise of the solution or before completion of viscosity rise of the solution for reaction so as to prepare a hardenable polymer, and mixing the obtained hardenable polymer with the coating solvent.

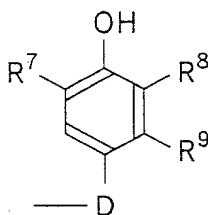
48. The production method for a hardenable resin composition according to claim 47, wherein the material polymer is prepared by polymerization of a compound having a double bond-containing group and an acidic functional group with a compound having a double bond-containing group and a hydroxyl group, using a non-nitrile azo-based polymerization initiator or a peroxide-based polymerization initiator, and the material polymer is reacted with the isocyanate compound, using a polymerization inhibitor selected from the group consisting of a phenol-based compound represented by the below-mentioned formula (10) and a phosphite-based compound represented by the below-mentioned formula (16):

Formula (10)



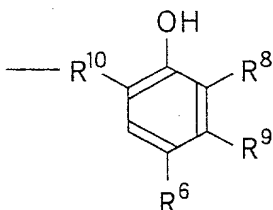
wherein R^6 is hydrogen, an alkyl group having 1 to 5 carbon atoms, or the below-mentioned formula (11):

Formula (11)



wherein D in the formula (11) is -S-, an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon atoms. R^7 is hydrogen or an alkyl group having 1 to 10 carbon atoms. R^8 is hydrogen, an alkyl group having 1 to 10 carbon atoms, or the below-mentioned formula (12):

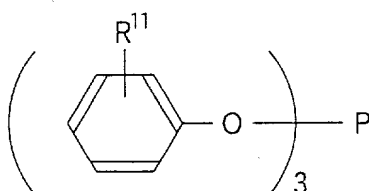
Formula (12)



wherein R^{10} in the formula (12) is an alkylene group having 1 to 10 carbon atoms or an alkylidene group having 1 to 10 carbon

atoms. R^9 is hydrogen or an alkyl group having 1 to 10 carbon atoms. However, at least one of R^7 and R^8 is a tert-butyl group, or an alkyl group having a cyclohexyl group. Moreover, substituents of the same numeral can either be same or different.

Formula (16)



wherein R^{11} is hydrogen or an alkyl group having 1 to 20 carbon atoms.

49. The production method for a hardenable resin composition according to claim 48, wherein a polymer having a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 400 nm being 60% or more is prepared by reacting the material polymer with an isocyanate compound, and applying the alcohol treatment to the polymer.

50. The production method for a hardenable resin composition according to claim 48, wherein a polymer having a light transmittance of a 3-methoxy butyl acetate solution of a 20% by weight resin solid component placed in a 1 cm square quartz cell at 360 nm being 50% or more is prepared by reacting the

Descriptive statistics	
Number of respondents	100
Age (mean)	30.5
Gender (male/female)	50/50
Education (mean)	12.5
Income (mean)	15.2
Occupation (mean)	1.2
Marital status (mean)	1.5
Religious affiliation (mean)	1.8
Political affiliation (mean)	1.5
Health status (mean)	1.2
Stress level (mean)	1.5
Life satisfaction (mean)	1.8
Work-life balance (mean)	1.5
Family support (mean)	1.2
Community support (mean)	1.5
Healthcare access (mean)	1.2
Financial stability (mean)	1.5
Emotional well-being (mean)	1.2
Social support (mean)	1.5
Physical health (mean)	1.2
Mental health (mean)	1.5
Overall quality of life (mean)	1.8
Work-life balance (mean)	1.5
Family support (mean)	1.2
Community support (mean)	1.5
Healthcare access (mean)	1.2
Financial stability (mean)	1.5
Emotional well-being (mean)	1.2
Social support (mean)	1.5
Physical health (mean)	1.2
Mental health (mean)	1.5
Overall quality of life (mean)	1.8

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FIG. 1

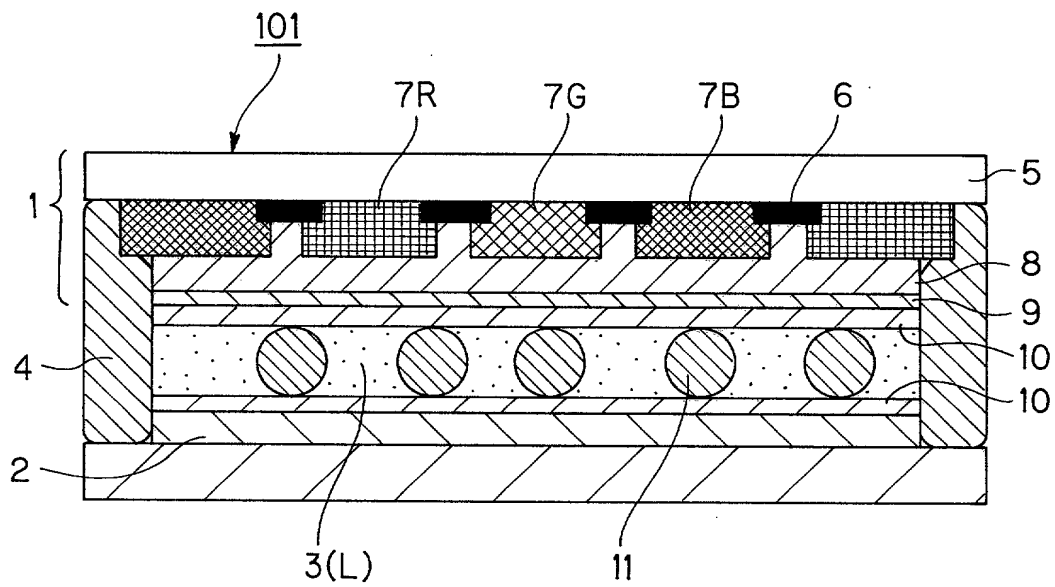


FIG. 2

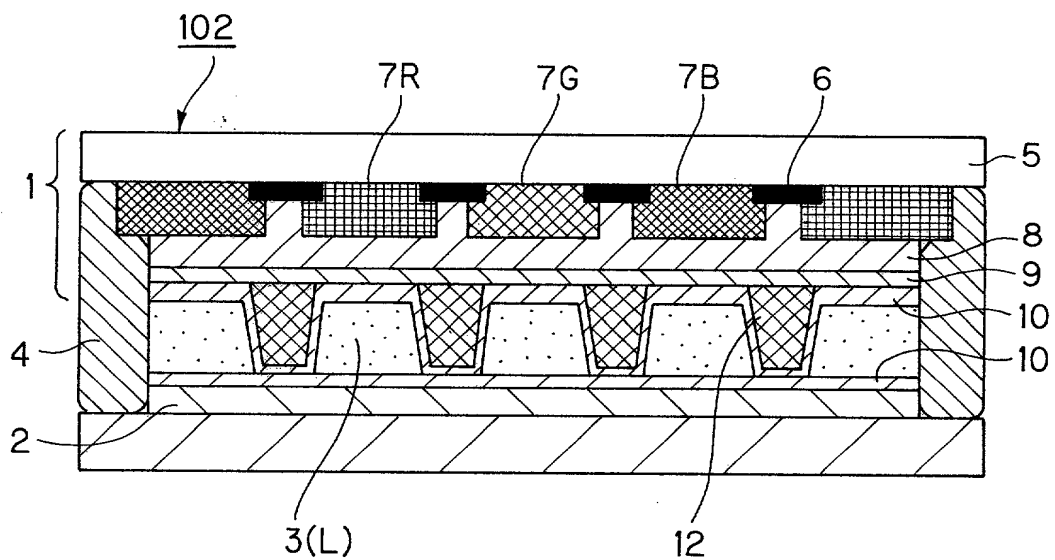


FIG. 3

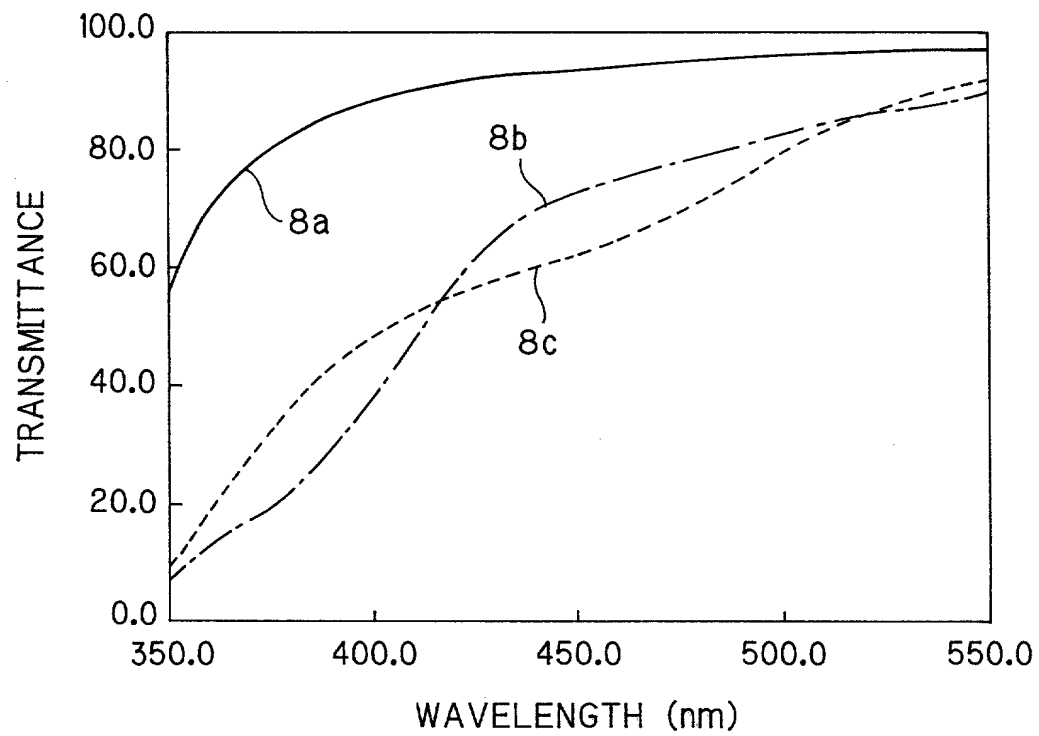
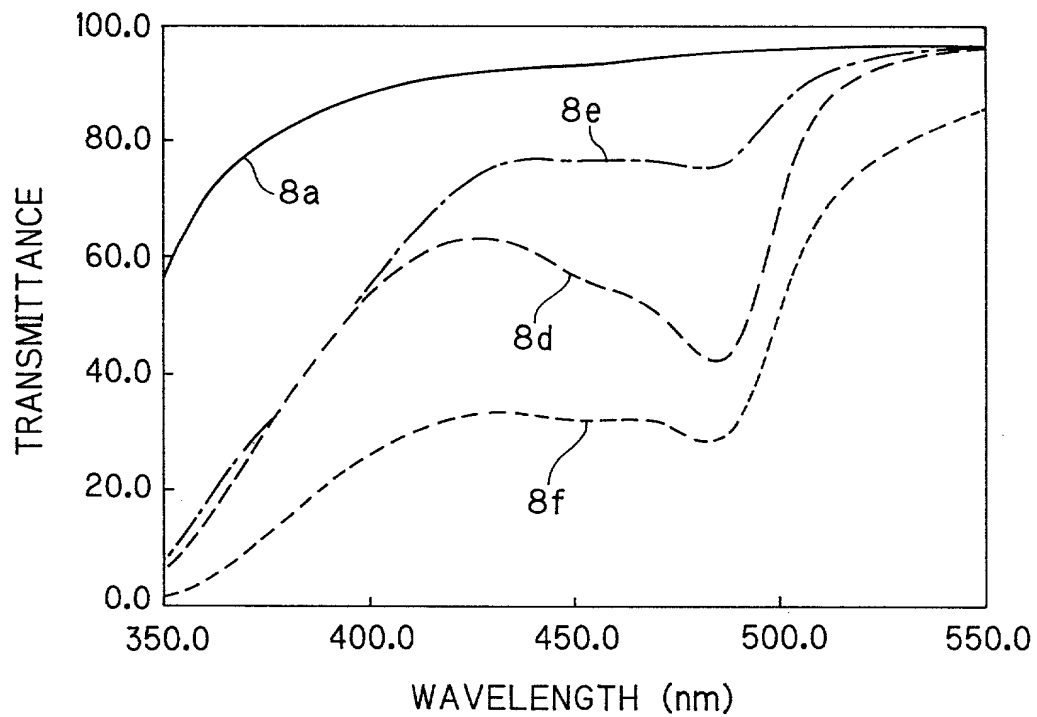


FIG. 4



Declaration and Power of Attorney for Patent Application

001-4120

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

私は、以下に記名された発明者として、ここに下記の通り宣言する：

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先そして国籍は、私の氏名の後に記載された通りである。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明について、特許請求範囲に記載され、且つ特許が求められている発明主題に関して、私は、最初、最先且つ唯一の発明者である（唯一の氏名が記載されている場合）か、或いは最初、最先且つ共同発明者である（複数の氏名が記載されている場合）と信じている。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HIGHLY STABLE RESIN, HARDENABLE

RESIN COMPOSITION, PRODUCTION
METHOD THEREFOR, COLOR FILTER AND

LIQUID CRYSTAL PANEL

上記発明の明細書はここに添付されているが、下記の欄がチェックされている場合は、この限りでない：

the specification of which is attached hereto unless the following box is checked:

☐ _____ の日に出願され、
この出願の米国出願番号またはPCT国際出願番号は、
_____ であり、且つ
_____ の日に補正された出願（該当する場合）

☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

私は、上記の補正書によって補正された、特許請求範囲を含む上記明細書を検討し、且つ内容を理解していることをここに表明する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編規則1.56に定義されている、特許性について重要な情報を開示する義務があることを認める。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the need of the individual case. Any comments on the amount of time you are required to complete this form should be sent to Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner of Patents and Trademarks, Washington, DC 20231.

Japanese Language Declaration (日本語宣言書)

私は、ここに、以下に記載した外国での特許出願または発明者証の出願、或いは米国以外の少なくとも一国を指定している米国法典第35編第365条(a)によるPCT国際出願について、同第119条(a)-(d)項又は第365条(b)項に基づいて優先権を主張するとともに、優先権を主張する本出願の出願日より前の出願日を有する外国での特許出願または発明者証の出願、或いはPCT国際出願については、いかなる出願も、下記の枠内をチェックすることにより示した。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application for which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

Priority Not Claimed
優先権主張なし

P11-227072	Japan	11/08/1999	<input type="checkbox"/>
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)	
P11-288803	Japan	08/10/1999	<input type="checkbox"/>
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願日/月/年)	

私は、ここに、下記のいかなる米国仮特許出願についても、その米国法典第35編119条(e)項の利益を主張する。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)
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私は、ここに、下記のいかなる米国出願についても、その米国法典第35編第120条に基づく利益を主張し、又米国を指定するいかなるPCT国際出願についても、その同第365条(c)に基づく利益を主張する。また、本出願の各特許請求の範囲の主題が、米国法典第35編第112条第1段に規定された態様で、先行する米国出願又はPCT国際出願に開示されていない場合においては、その先行出願の出願日と本国内出願日またはPCT国際出願日との間の期間中に入手された情報で、連邦規則法典第37編規則1.56に定義された特許性に関わる重要な情報について開示義務があることを承認する。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況: 特許許可、係属中、放棄)
(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況: 特許許可、係属中、放棄)

私は、ここに表明された私自身の知識に係わる陳述が真実であり、且つ情報と信ずることに基づく陳述が、真実であると信じられることを宣言し、さらに、故意に虚偽の陳述などを行った場合は、米国法典第18編第1001条に基づき、罰金または拘禁、若しくはその両方により処罰され、またそのような故意による虚偽の陳述は、本出願またはそれに対して発行されるいかなる特許も、その有効性に問題が生ずることを理解した上で陳述が行われたことを、ここに宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration (日本語宣言書)

委任状： 私は本出願を審査する手続を行い、且つ米国特許商標庁との全ての業務を遂行するために、記名された発明者として、下記の弁護士及び／または弁理士を任命する。(氏名及び登録番号を記載すること)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number).

書類送付先 Timothy J. Keefer, 35,567;
Douglas S. Rupert, 44,434;
Carmen B. Patti, 26,784;
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Gary R. Gillen, 35,157;
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(第三以下の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for third and subsequent joint inventors.)